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Laser backscatter measurements of the lower atmosphere

M. Patrick McCormick
College of William & Mary - Arts & Sciences

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APPROVAL SHEET

This thesis is submitted in partial fulfillment of

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Michael Patrick McCormick

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James D. Lawrence, Jr., Ph.D.

Rolf G. Winter, D.Sc.

George S. Ofelt, Ph.D.

Howard R. Gordon, Ph.D.

Joseph T. Zung, Ph.D.

Stuart L. Seaton, D.Sc.

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ABSTRACT

Laser backscatter measurements of the atmosphere to 28 km at 6943 Å have been used to develop a model for the clear atmosphere. Absolute volume backscatter cross sections and attenuation coefficients have been calculated using rigorous Mie theory for the aerosol component and Rayleigh theory for the molecular component. Aerosol scattering cross sections for a Junge size distribution have been computed for various atmospheric radii limits, size parameter increments, and size distribution parameters at four laser wavelengths for an index of refraction of 1.5.

The measurements made for the clear atmosphere show excellent agreement with model calculations based on direct aerosol samplings and the Junge fourth power size distribution law. In addition, a number of observations of meteorological phenomena are included which demonstrate potential applications of laser radar to meteorological studies.

The system developed to make laser backscatter measurements of the atmosphere is discussed in some detail. Design criteria and noise analysis to optimize the experimental system are given.

A complete listing of the single particle intensity functions and the intergrals appearing in the cross-section and attenuation coefficient equations for backscatter are given in the appendixes. Fortran IV computer programs to perform these calculations are also listed.

LASER BACKSCATTER MEASUREMENTS OF THE LOWER ATMOSPHERE

I. INTRODUCTION

An accurate description of the molecular and particulate content of the earth's atmosphere and their diurnal, seasonal, and altitude variation is necessary in order to derive an atmospheric model. Direct measurement of the lower atmosphere can be made by balloon-borne instruments and rocket probes. These measurements, however, are made in a perturbed atmosphere which complicates interpretation and are subject to environmental factors which make systematic observation difficult. Satellite measurements, on the other hand, are limited to heights above 150 km. Indirect light scattering methods have, in consequence, necessarily dominated investigations up to 150 km. These methods include measurements of the twilight sky, balloon-borne coronagraph measurements of scattered solar radiation, and searchlight probe techniques. The searchlight probe technique was first attempted by Synge[1] in 1930, and a number of subsequent searchlight investigations have been carried out[2-9]. A recent comprehensive study of the particulate content of the atmosphere by measurement of twilight scattering has been performed by Volz and Goody[10]. Newkirk and Eddy[11] have made skylight measurements up to 25 km using a balloon-borne coronagraph, and from these measurements have calculated the particle size and vertical distribution of stratospheric aerosols. Direct measurement of tropospheric and stratospheric aerosols has been made by Junge and Manson[12], Chagnon and Junge[13], and Rosen[14].

The recent development of the high intensity giant pulse laser has placed new emphasis on indirect investigations of the atmosphere. Its characteristics coupled with developments in computer and detector technology enable the investigator to significantly extend observations of the atmospheric structure and for the first time place these measurements on a firm theoretical basis. Using this technique Fiocco and Smullin[15] have reported optical echoes from heights to about 140 km, which they have tentatively interpreted in terms of meteoric fragmentation. They report weak echoes from two main regions: 60 to 90 km and 110 to 140 km. Subsequent investigations[16,17] have failed to confirm their results. Fiocco and Grams[18] and Clemenshaw, et al.[16] have reported observing an aerosol layer at approximately 20 km. Observation of the stratospheric aerosol have also been made by Collis and Ligda[19] and Collis, Fernald, and Ligda[20].

This paper describes the laser backscatter measurements made at the College of William and Mary and establishes a theoretical basis for determining the atmospheric structure from these measurements.

II. THEORETICAL CONSIDERATIONS

The atmosphere will be considered a mixture of aerosols describable by Mie Theory, and molecules describable by Rayleigh Theory. If an electromagnetic flux F is incident on a volume ΔV, the power scattered into a detector which subtends a solid angle Ω is given by

$$P_{detector} = Fq(\sigma_R + \sigma_{Mie})\,\Delta V \Omega \tag{1}$$

where $\sigma_R + \sigma_{Mie}$ is the scattering cross section per unit volume, assumed to include both Rayleigh scatter (σ_R) and Mie scatter (σ_{Mie}). q is the attenuation of the wave (total extinction) in propagating from the scatterer to the detector. In general, the cross sections σ_R and σ_{Mie} depend on the angle between the incident propagation direction and the scattered propagation direction, and on the polarization state of the incident radiation. The scattering volume is given by

$$\Delta V = \frac{\pi}{4}(Z\delta_T)^2\,\Delta L \tag{2}$$

where

Z = height of scattering volume

δ_T = beam divergence angle of laser

ΔL = pulse length (determined by half-power points)

The solid angle subtended by the detector is

$$\Omega = \frac{A_r}{Z^2} \tag{3}$$

where A_r is the area of the receiver.

The incident flux is given by

$$F = q \frac{\overline{P}}{\frac{\pi}{4}(Z\delta_T)^2} \tag{4}$$

where $\overline{P}$ is the average power delivered by the laser. Substituting equations (2), (3), and (4) into equation (1), we obtain

$$P_{det} = \frac{\overline{P}\,\Delta L q^2 A_r}{Z^2}(\sigma_R + \sigma_{Mie}) \tag{5}$$

IIa. <u>Rayleigh Scattering</u>

The absolute Rayleigh cross section for backscatter is

$$\sigma_R = k^4 \overline{\alpha}^2 N_R(Z) f \tag{6}$$

where

$$k = \frac{2\pi}{\lambda} = \text{wave number of incident radiation}$$

$$\overline{\alpha} = \text{polarizability}$$

$$N_R(Z) = \text{molecular number density}$$

and

$$f = \frac{3(2 + \Delta)}{6 - 7\Delta}$$

f accounts for the depolarization attributable to the anisotropy of scatterer. Δ is the depolarization factor which for atmospheric air was found by G. de Vaucouleurs[21] to be

$$\Delta = 0.031$$

Thus,

$$f = 1.054$$

The polarizability of sea level air for optical radiation is given as

$$\bar{\alpha} = 1.73 \times 10^{-30} \ m^3$$

which is valid for the first 80 km of the earth's atmosphere since the mean molecular mass is nearly constant. This value of $\bar{\alpha}$ assumes that the wavelength of incident radiation does not correspond to an absorption region. Therefore,

$$\sigma_R = 2.087 \times 10^{-32} \ N_R(Z) \ m^{-1} \text{sterad}^{-1}$$

Then the power incident on the detector due to the molecular component of the atmosphere is given as

$$P_{R \ det} = 2.087 \times 10^{-32} \ \frac{\bar{P} \ \Delta L q^2 A_r N_R(Z)}{Z^2} \ \text{watts} \tag{7}$$

where

$$\Delta L = \frac{c\tau}{2}$$

since the light will be received simultaneously from $\frac{c\tau}{2}$; that is, only half the scattering volume contributes to the instantaneous backscatter. τ is the pulse width measured at half-power points.

For the 60-inch-diameter collector ($A_r = 1.823 \ m^2$) of approximately 0.5 optical efficiency used in our system, the power at the detector due to molecular scatter becomes

$$P_{R \ det} = 2.851 \times 10^{-24} \ \frac{\bar{P} \tau q^2 N_R(Z)}{Z^2} \ \text{watts}$$

Assuming the laser energy output is 1 joule,

$$\bar{P} = \frac{1 \ \text{joule}}{\tau}$$

Then,

$$P_{R\ det} = 2.851 \times 10^{-24} \frac{q^2 N_R(Z)}{Z^2} \text{ joules sec}^{-1}$$

The photomultiplier used is an RCA 7265 whose cathode radiant sensitivity at 0.6943μ is approximately 0.014 amp/watt. The gain is given as 9.35×10^6. Assuming an optical efficiency of 0.7 for the filter system, the detected anode current is

$$i_{R\ det} = 2.612 \times 10^{-19} \frac{q^2 N_R(Z)}{Z^2} \text{ amperes} \tag{8}$$

In order to determine the attenuation due to molecular scattering, the attenuation coefficient β_R must be calculated. β_R gives the total amount of energy scattered out of the laser beam per unit path length and is found by integrating the scattering cross section over 4π steradians. The absolute cross section for molecular scattering is given by

$$\sigma_R = \frac{1}{2}(1 + \cos^2\theta)k^4|\overline{\alpha}|^2 N_R(Z)f \tag{9}$$

The attenuation coefficient becomes, therefore,

$$\beta_R = \int_0^{2\pi} \int_0^{\pi} \frac{1}{2}(1 + \cos^2\theta)k^4|\overline{\alpha}|^2 N_R(Z)f \sin\theta \, d\theta \, d\varphi$$

Integration yields

$$\beta_R = 4.12 \times 10^{-39} \frac{N_R(Z)}{\lambda^4} \text{ km}^{-1} \tag{10}$$

where λ is measured in cm and $N_R(Z)$ in molecules cm^{-3}. β_R as a function of altitude computed for the U.S. Standard Atmosphere 1962[22] and $\lambda = 6943$ Å is shown in figure 2. Scattering by the large particle component of the atmosphere is treated in the section to follow.

IIb. Scattering by Large Particles

Any investigation of the scattering properties of the atmosphere must take into consideration the contribution of large particles. The solid and liquid particles suspended in the lower atmosphere with radii from 0.04 to 20μ (aerosols) dominate the scattering properties of the first several kilometers and contribute significantly at heights well above 20 km. In addition, the influx of meteoric material strongly influences the scattering properties of the upper atmosphere. To determine the contribution of this large particle or aerosol component, the number density, size, shape, composition, and angular dependence of scattered light must be known. These quantities will be examined in order to develop a model for large particle scattering. The problem then is to infer the number density and size distribution of the large particle collection by measurement of a monochromatic scattering cross section at several wavelengths. It is necessary to assume that the large particles present in the atmosphere are spherical and that the index of refraction of the collection can be represented by an average value either real or complex. These two assumptions impose limitations on the model derived; they are, however, generally supported by a large body of experimental evidence.

The problem of scattering of electromagnetic waves by a spherical boundary of arbitrary radius and index of refraction was first solved by G. Mie(23) in 1908. The exact solution for the scattered amplitude is an infinite series of products of Bessel functions of the particle radius and Legendre polynomials which are functions of the scattering angle. The complete Mie formulae are summarized in Appendix I.

Assuming that the particulate matter present in the atmosphere may be considered a collection of spherical particles of index of refraction η, the absolute scattering cross section is given by

$$\sigma_{Mie} = \frac{1}{k^2} \sum_{r} i(\alpha,\eta,\theta) N_{Mie}(r,Z) \tag{11}$$

where

$$i(\alpha,\eta,\theta) = \frac{i_1(\alpha,\eta,\theta) + i_2(\alpha,\eta,\theta)}{2} = \text{the Mie intensity function}$$

(see Appendix I)

$i_{1,2}(\alpha,\eta,\theta)$ = intensity of light with electric vector perpendicular and parallel to the plane through the direction of propagation of the incident and scattered beam, respectively

$N_{Mie}(r,Z)$ = the number density of particles of radius r at height Z

and

$$\alpha = \frac{2\pi r}{\lambda} = \text{the particle size parameter}$$

The Mie intensity functions exhibit large variations for small intervals of wavelength or radius; therefore computations must be performed in very small increments of α. A table of these single particle intensity functions for $\eta = 1.5$ and $\theta = 180^\circ$ (backscatter) appears in Appendix II. For a continuous size distribution of aerosols, equation (11) can be written as

$$\sigma_{Mie} = \int_{r_1}^{r_2} \frac{i(\alpha,\eta,\theta)}{k^2} \, dn(r,Z) \tag{12}$$

The number density and size distribution of tropospheric and stratospheric aerosols have been studied by many investigators. Junge[12,13,24] has found that the size distribution of collected atmospheric aerosols could be fitted by

$$dn(r,Z) = a(Z)r^{-\nu}\ d\ \log r = c(Z)r^{-(\nu+1)}\ dr \tag{13}$$

where $dn(r,Z)/dr$ is the particle concentration (m^{-4}), the exponent ν determines the relative amount of small particles and can change with height, and $c(Z)$ is dependent on the total number of particles per unit volume and is therefore a function of height. $c(Z)$ can be found from

$$N_{Mie}(Z) = \int_{r_1}^{r_2} dn(r,Z) = c(Z) \int_{r_1}^{r_2} r^{-(\nu+1)}\ dr \tag{14}$$

where $N_{Mie}(Z)$ is the total number of particles per unit volume. For the atmospheric aerosol distribution $r_2 \gg r_1$. Therefore,

$$N_{Mie}(Z) \approx \frac{c(Z)}{\nu {r_1}^{\nu}}$$

Substituting the Junge distribution into equation (12) gives

$$\sigma_{Mie} = c(Z) \int_{r_1}^{r_2} \frac{i(\alpha,\eta,\theta)}{k^2 r^{\nu+1}}\ dr \tag{15}$$

which gives the absolute scattering cross section for large particles. The above equation may be written in the terms of the size parameter as

$$\sigma_{Mie} = c(Z)\left(\frac{2\pi}{\lambda}\right)^{\nu-2} \int_{\alpha_1}^{\alpha_2} \frac{i(\alpha,\eta,\theta)}{\alpha^{\nu+1}}\ d\alpha$$

or in the more general form

$$\sigma_{Mie} = \frac{c(Z)}{2}\left(\frac{2\pi}{\lambda}\right)^{\nu-2} \Phi \tag{16}$$

where

$$\Phi = \int_{\alpha_1}^{\alpha_2} \frac{i_1(\alpha,\eta,\theta) + i_2(\alpha,\eta,\theta)}{\alpha^{\nu+1}} \, d\alpha$$

The majority of direct aerosol measurements such as those by Junge[12,13,24] and Moore[25] and the indirect optical measurements such as those by Bullrich[26] and Volz[27] indicate that $\nu = 3$ gives the best average fit to the natural size distribution of aerosols.

Since the single particle intensity function depends upon the dielectric constant and conductivity of the scatterer, an average index of refraction representative of the atmospheric aerosol must be chosen. Bullrich[26] gives a very comprehensive account of the aerosol composition and concludes that 1.5 is a reasonable estimate.

The model also requires a choice of upper and lower size limits. The size distribution of atmospheric aerosols ranges from molecular clusters to particles of about 20μ radius. The particles between molecular clusters and 0.04μ do not play an important role, however, in light scattering due to their relatively low concentration, while those above 10μ radius are reduced in number density by direct fallout and washout through cloud formation and precipitation. The limits will therefore be taken from 0.04μ to 10μ. The effect of other limits will be discussed in Section IIc.

To complete the model for large particle scattering, the aerosol number density as a function of altitude has to be determined. The attenuation coefficient and, therefore, the number density of the aerosols can be inferred by transmission measurements of the atmosphere. The attenuation coefficient β_{Mie} gives the total energy scattered out of the beam per unit length and is found by integrating the scattering cross section over a sphere which from equation (12) is given as

$$\beta_{Mie} = \int_{r_1}^{r_2} 2\pi \int_{0}^{\pi} \frac{i(\alpha,\eta,\theta)}{k^2} \sin\theta \, d\theta \, dn(r,Z) \tag{17}$$

The dimensionless scattering cross section Q_S is given as

$$Q_S = \frac{2}{r^2} \int_{0}^{\pi} \frac{i(\alpha,\eta,\theta)}{k^2} \sin\theta \, d\theta$$

which is the single particle scattering cross section divided by the geometrical cross section. For real index, Q_S can also be written as

$$Q_S = \frac{2}{\alpha^2} \sum_{m=1}^{\infty} (2m + 1)\mathrm{Re}(a_m + b_m)$$

Therefore, equation (17) becomes

$$\beta_{Mie} = c(Z)\pi\left(\frac{2\pi}{\lambda}\right)^{\nu-2} K \tag{18}$$

where

$$K = \int_{\alpha_1}^{\alpha_2} \frac{Q_S}{\alpha^{\nu-1}} \, d\alpha$$

Since $c(Z) \approx \nu r_1^{\nu} N_{Mie}(Z)$, β_{Mie} becomes

$$\beta_{Mie} = \nu \alpha_1^{\nu} \pi \left(\frac{\lambda}{2\pi}\right)^2 N_{Mie}(Z) K \tag{19}$$

for a given choice of parameters β_{Mie} can be written

$$\beta_{Mie} = \text{constant } N_{Mie}(Z)$$

β_{Mie} has been measured for the clear atmosphere by Curcio[28]. Further, the essential attenuation features of the atmosphere are determined by particles in the size range $0.1\mu < r < 1.0\mu$. A value of $N_{Mie}(0)$, therefore, may be calculated from equation (19). K is tabulated for various values of the parameters in Appendix III. For $\nu = 3$ and $r_1 = 0.125\mu$, equation (19) gives

$$N_{Mie}(0) = 450 \text{ particles cm}^{-3}$$

In order to fit the experimental data obtained, two model atmospheres have been examined. The first, referred to as Model I, uses the direct measurements from 5 to 28 km by Rosen[14] in a series of six balloon flights. Under 5 km, the sea level value of 450 particles cm^{-3} deduced in the previous paragraph has been exponentially interpolated to Rosen's value at 5 km. The aerosol number density profile for this model is given in figure 1. Model II is also given in figure 1. For the altitude range 0 to 5 km, the scale height for Model II is Penndorf's[30] value calculated from solar attenuation measurements made by Krug[31]. From 11 to 27 km, an average of Chagnon and Junge's[13] direct sampling measurements are taken. Model II is completed by interpolating

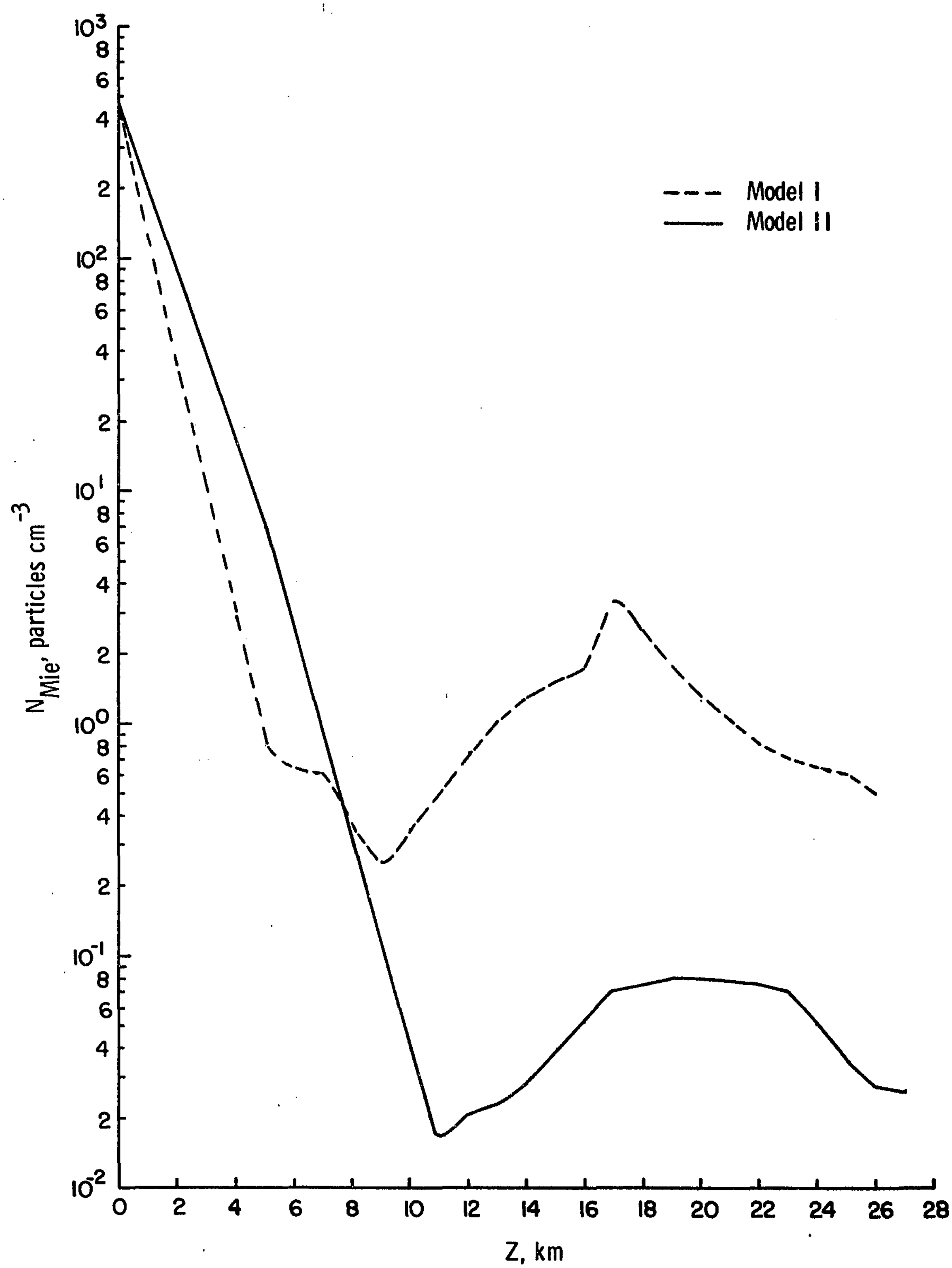

Figure 1.- Aerosol number density versus altitude for two atmospheric models.

exponentially between N_{Mie} (5 km) and N_{Mie} (11 km). Model II is similar to Elterman's Clear Atmospheric Model[29]; the Elterman model, however, assumes $N_{Mie}(0) = 215$ particles cm^{-3} and considers only one of Chagnon and Junge's measurements for the interval 11 to 27 km.

For the two model aerosol atmospheres discussed in the previous paragraph, the absolute scattering cross section as a function of height can be calculated as follows: Equation (16) with $\nu = 3$ becomes

$$\sigma_{Mie} = 2.925 \times 10^{-15} N_{Mie}(Z)\left(\frac{2\pi}{\lambda}\right)\int_{\alpha_1}^{\alpha_2} \frac{i_1(\alpha,1.5,\theta) + i_2(\alpha,1.5,\theta)}{\alpha^4}\,d\alpha \tag{20}$$

The value of the integral in equation (20) for $\lambda = 0.6943\mu$, $\eta = 1,5$, $\theta = 180^{\circ}$, and $\nu = 3$ was calculated (see Appendix III) to be 0.4485. The calculation was performed for $\alpha = 0.362(0.1)90.5$. Therefore, the absolute cross section for backscatter of ruby laser radiation is given as

$$\sigma_{Mie} = 1.176 \times 10^{-5} N_{Mie}(Z) \tag{21}$$

Similarly, the integral in β_{Mie} was calculated to be 1.845, and thus

$$\beta_{Mie} = 3.032 \times 10^{-4} N_{Mie}(Z) \tag{22}$$

σ_{Mie}, β_{Mie}, σ_{total}, and β_{total} are plotted for the two model atmospheres in figures 2, 3, 4, and 5. Listed in table I are the values of β_R, β_O, and β_{Mie} (for Model I) and the optical depth t, where the transmissivity q is given by

$$q = e^{-t} = e^{-\int_0^Z \left[\beta_R(Z) + \beta_{Mie}(Z) + \beta_O(Z)\right]dZ}$$

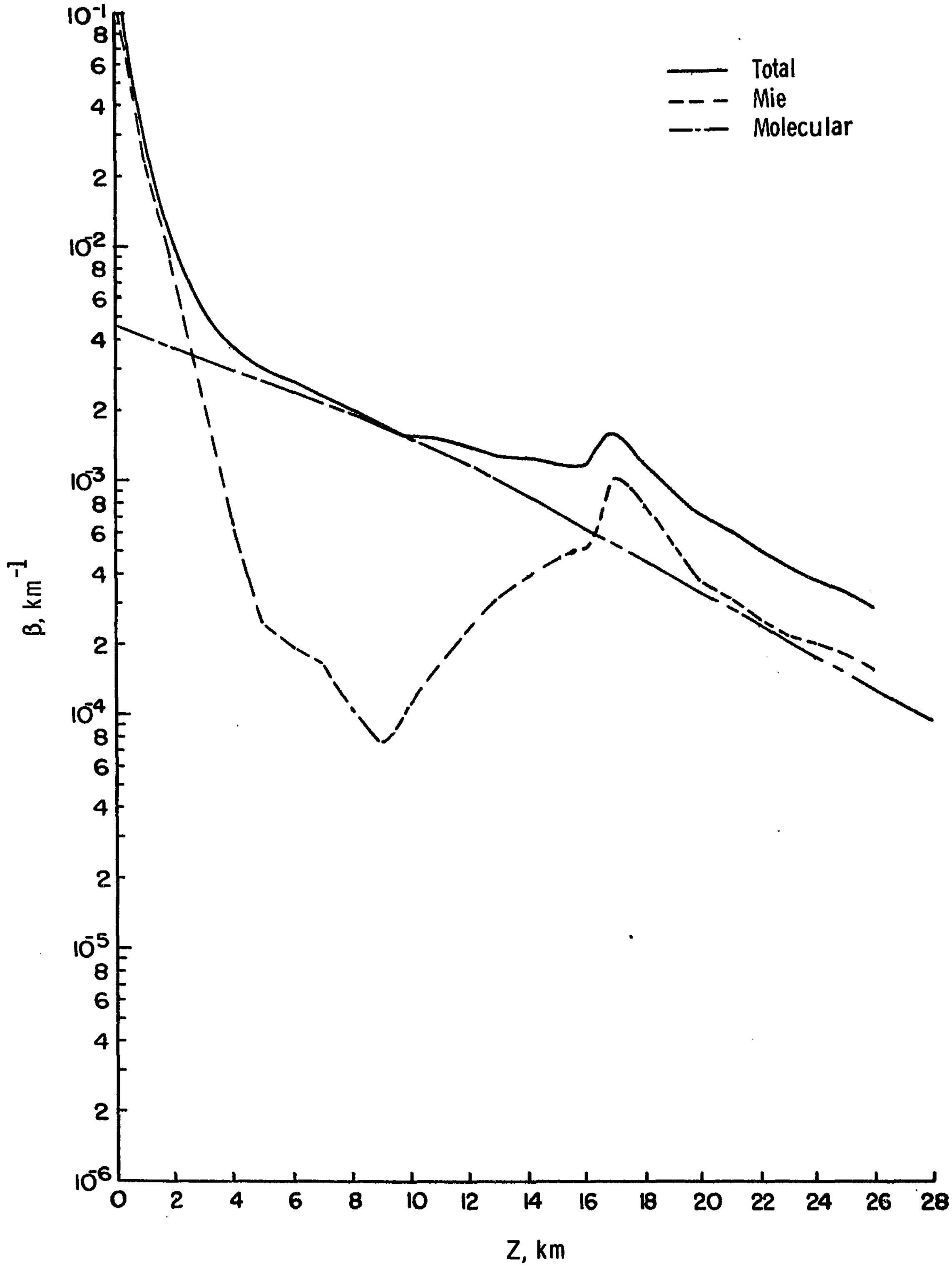

Figure 2.- Molecular and model I aerosol attenuation coefficients versus altitude. The sum is shown also.

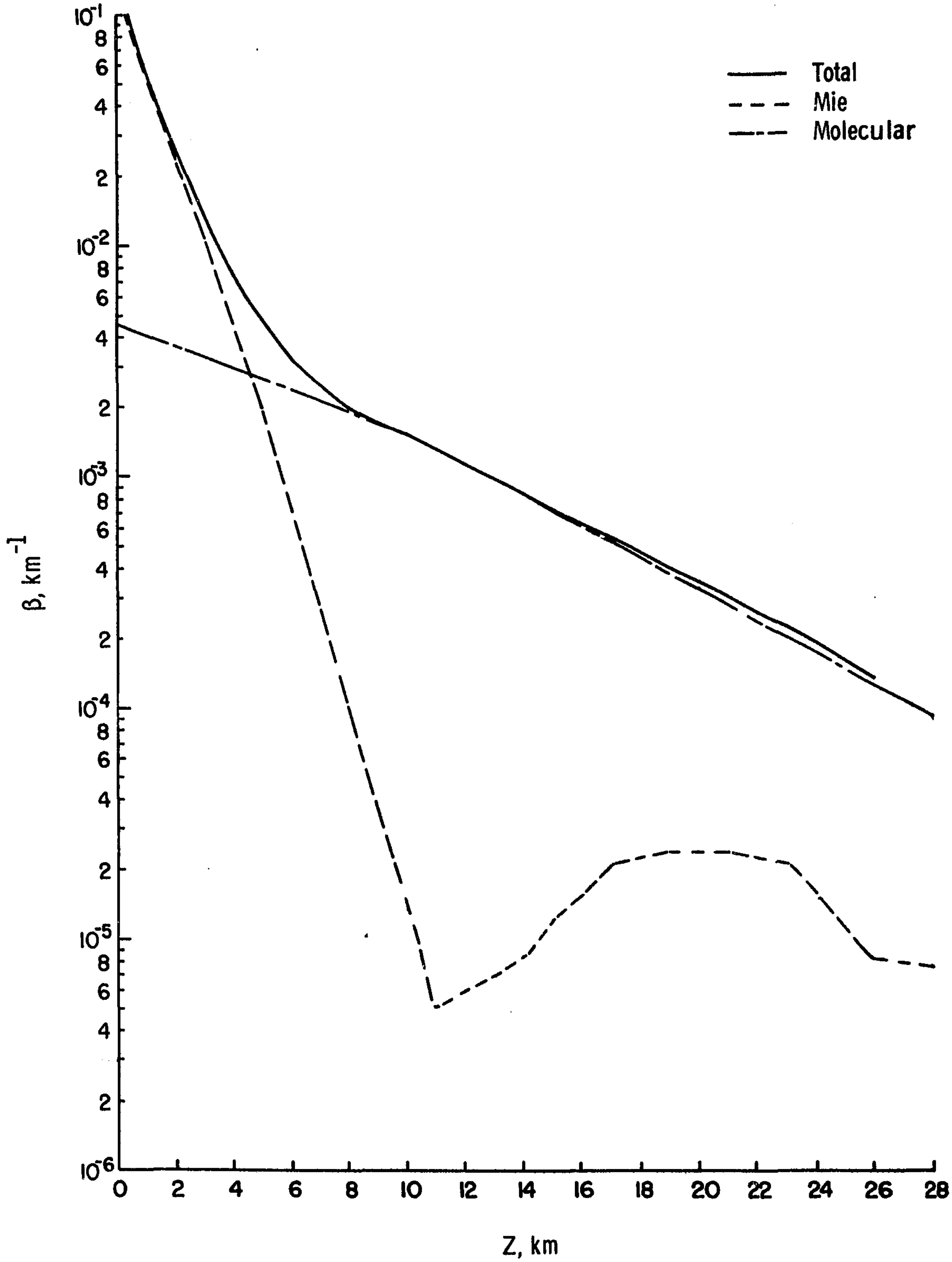

Figure 3.- Molecular and model II aerosol attenuation coefficients versus altitude. The sum is shown also.

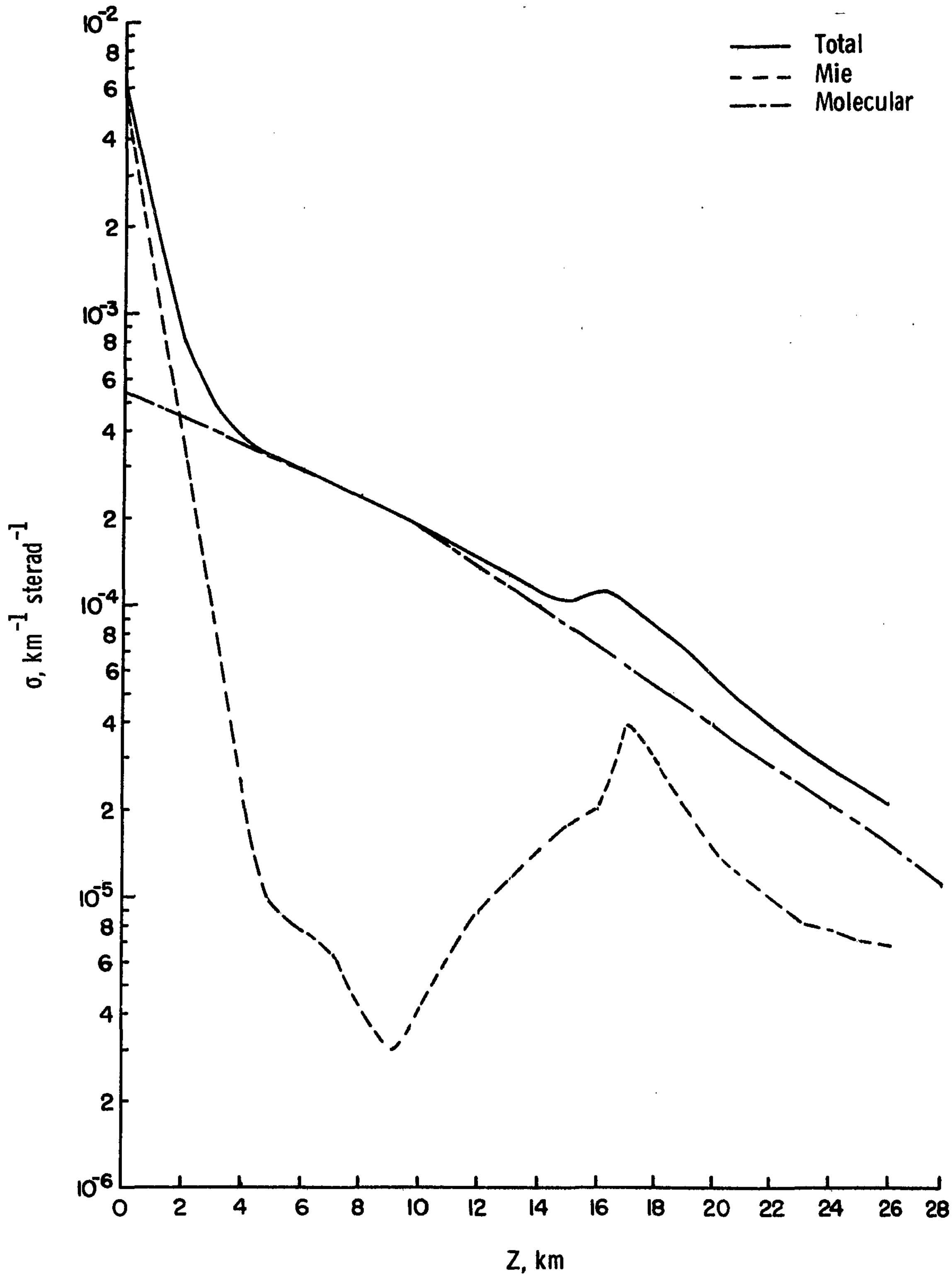

Figure 4.- Molecular and model I aerosol absolute backscatter cross sections versus altitude. The sum is shown also.

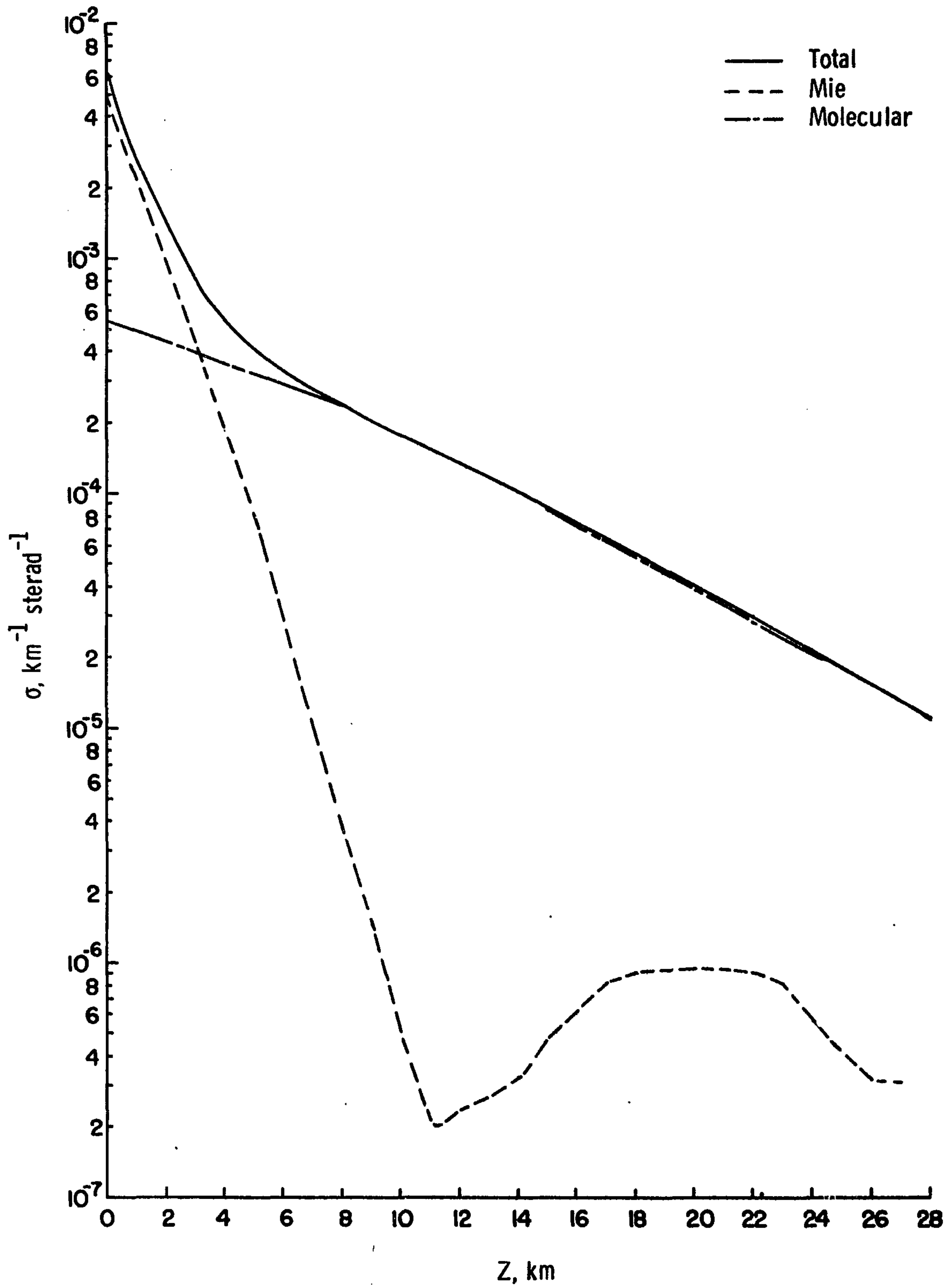

Figure 5.- Molecular and model II aerosol absolute backscatter cross sections versus altitude. The sum is shown also.

TABLE I. - MOLECULAR, AEROSOL, AND OZONE ATTENUATION COEFFICIENTS

Z	β_R (km^{-1})	β_{Mie} (km^{-1})	β_{Ozone} (km^{-1})	β_{Total} (km^{-1})	t
0	4.5×10^{-3}	1.36×10^{-1}	9.8×10^{-5}	1.41×10^{-1}	0
1	4.09	3.49×10^{-2}	8.98	3.91×10^{-2}	.09
2	3.70	8.94×10^{-3}	8.07	1.27×10^{-2}	.116
3	3.35	2.43×10^{-3}	6.88	5.85×10^{-3}	.125
4	3.01	6.52×10^{-4}	6.22	3.72×10^{-3}	.130
5	2.71	2.43	6.08	3.01	.133
6	2.42	1.97	5.95	2.68	.136
7	2.18	1.67	6.14	2.41	.138
8	1.93	1.06	6.27	2.1	.141
9	1.72	7.58×10^{-5}	7.73	1.87	.143
10	1.52	1.06×10^{-4}	9.67	1.72	145
11	1.34	1.52	1.27×10^{-4}	1.62	.146
12	1.15	2.27	1.71	1.55	.148
13	9.81	3.03	2.32	1.52	.150
14	8.39	3.79	2.63	1.48	.151
15	7.17	4.55	2.74	1.45	.153
16	6.12	5.15	2.84	1.41	.154
17	5.24	1.0×10^{-3}	3.05	1.84	.156

TABLE I - cont.

Z	β_R km^{-1})	β_{Mie} (km^{-1})	β_{Ozone} (km^{-1})	β_{Total} (km^{-1})	t
18	4.48	7.58×10^{-4}	3.36	1.54	.157
19	3.82	5.31	3.91	1.30	.159
20	3.27	3.79	4.51	1.16	.160
21	2.78	3.18	5.06	1.10	.161
22	2.37	2.43	5.42	1.02	.162
23	2.02	2.12	5.45	9.59×10^{-4}	.163
24	1.73	1.97	5.31	9.01	.164
25	1.47×10^{-4}	1.82×10^{-4}	4.96×10^{-4}	8.25×10^{-4}	.164
26	1.26	1.52	4.49	7.27	.165
27	1.08	1.2	3.88	6.16	.165
28	9.22×10^{-5}	1.0	3.39	5.31	.165
29	7.91	8.8×10^{-5}	2.94	4.61	.166
30	6.78	7	2.49	3.87	.166
35	3.12		1.19	1.50	.167
40	1.47	Assume 0	5.12×10^{-5}	6.95×10^{-5}	.167
45	7.24×10^{-6}		1.58	2.30	.167
50	3.79		5.12×10^{-6}	8.91×10^{-6}	.167

The power incident on the detector due to large particle backscatter can now be calculated. Combining equations (5) and (21) gives

$$i_{\text{Mie det}} = 0.1472 \frac{q^2 N_{\text{Mie}}(Z)}{Z^2} \text{ amperes} \tag{23}$$

The transmissivity q, of the atmosphere for Model I, is given in table II. These calculations include Elterman's[29] ozone absorption values interpolated to $\lambda = 0.6943\mu$.

The total power incident on the detector calculated from equations (8) and (23) is listed in table II. The Mie values are those calculated for Model I. Experimentally, the output of the photomultiplier detector is displayed on an oscilloscope and recorded on film. Examination of equations (8) and (23) shows that $Z^2V(t)$ is proportional to $q^2(Z)\left[N_R(Z) + N_{\text{Mie}}(Z)\right]$, where $V(t)$ is the photomultiplier output at time t, and $Z = \frac{ct}{2}$. The values of Z^2V assuming Model I are listed in table III and plotted in figure 6.

IIc. Scattering Cross Section Dependence on Particle Size Distribution, Wavelength, and Particle Size Limits

Equations (16) and (18) constitute a rigorous description of atmospheric aerosol scattering assuming spherical particles and the Junge size distribution law. Bullrich[26] has tabulated values of the integral Φ for $\alpha = 0.1(0.2)159$ and $\eta = 1.5$. The range of parameters included, however, does not cover the entire atmospheric aerosol distribution for the four laser wavelengths available for this experiment. It has been necessary, therefore, to carry out extensive computations in order to evaluate Φ for parameters relevant to laser backscatter experiments.

TABLE IIA. - THE EXPECTED CURRENT AT THE DETECTOR DUE

TO MOLECULAR BACKSCATTER

Z (km)	N_R (m^{-3})	$\frac{N_R}{Z^2}$ (m^{-5})	q^2	$\frac{q^2 N_R}{Z^2}$ (m^{-5})	$i_{R\text{-}det}$ (amperes)
1	2.31	2.31×10^{19}	.835	1.93×10^{19}	5.12
2	2.09	5.23×10^{18}	.792	4.14×10^{18}	1.10
3	1.89	2.10	.779	1.64	4.35×10^{-1}
4	1.70	1.06	.771	8.17×10^{17}	2.17
5	1.53	$6.]2 \times 10^{17}$	.768	4.70×10^{17}	1.25×10^{-1}
6	1.37	3.81	.762	2.90	7.70×10^{-2}
7	1.23	2.51	.759	1.91	5.07
8	1.09	1.70	.753	1.28	3.40
9	9.71×10^{24}	1.20	.750	9.00×10^{16}	2.39
10	8.6	8.6×10^{16}	.748	6.43×10^{16}	1.71×10^{-2}
11	7.59	6.27	.746	4.68	1.24
12	6.49	4.51	.743	3.35	8.89×10^{-3}
13	5.54	3.28	.741	2.43	6.45
14	4.74	2.42	.738	1.79	4.75
15	4.05×10^{24}	1.8×10^{16}	.734	1.32×10^{16}	3.50×10^{-3}

TABLE II-A - cont.

Z	N_R (m^{-3})	$\frac{N_R}{Z^2}$ (m^{-5})	q^2	$\frac{q^2 N_R}{Z^2}$ (m^{-5})	$i_{R\text{-}det}$ (amperes)
16	3.46	1.35	.734	9.91×10^{15}	2.63
17	2.96	1.02	.731	7.46	1.98
18	2.53	7.80×10^{15}	.729	5.69	1.51
19	2.16	5.98	.726	4.34	1.15
20	1.85×10^{24}	4.63×10^{15}	.726	3.36×10^{15}	8.92×10^{-4}
21	1.57	3.56	.724	2.58	6.85
22	1.34	2.77	.723	2.00	5.31
23	1.14	2.16	.721	1.56	4.14
24	9.76×10^{23}	1.69	.721	1.22	3.24
25	8.34×10^{23}	1.33×10^{15}	.721	9.59×10^{14}	2.55×10^{-4}
26	7.12	1.05	.719	7.55	2.00
27	6.09	8.35×10^{14}	.719	6.00	1.59
28	5.21	6.65	.719	4.78	1.27
29	4.47	5.32	.717	3.81	1.01
30	3.83×10^{23}	4.26×10^{14}	.717	3.05×10^{14}	8.09×10^{-5}
31	3.28	3.41	.716	2.44	6.48

TABLE II-A - cont.

Z	N_R (m^{-3})	$\frac{N_R}{Z^2}$ (m^{-5})	q^2	$\frac{q^2 N_R}{Z^2}$ (m^{-5})	$i_{R\text{-}det}$ (amperes)
32	2.82	2.75	.716	1.97	5.23
33	2.41	2.21	.716	1.58	4.19
34	2.05	1.77	.716	1.27	3.37
35	1.76×10^{23}	1.44×10^{14}	.716	1.03×10^{14}	2.73×10^{-5}
36	1.51	1.17	.716	8.38	2.22
37	1.30	9.50	.716	6.80	1.80
38	1.12	7.76	.716	5.56	1.48
39	9.62×10^{22}	6.32	.716	4.53	1.20
40	8.31×10^{22}	5.19×10^{13}	.716	3.72×10^{13}	9.87×10^{-6}
41	7.19	4.28	.716	3.06	8.12
42	6.23	3.53	.716	2.53	6.71
43	5.40	2.92	.716	2.09	5.55
44	4.70	2.43	.716	1.74	4.62
45	4.09×10^{22}	2.02×10^{13}	.716	1.45×10^{13}	3.85×10^{-6}
46	3.56	1.68	.716	1.20	3.18
47	3.11	1.41	.716	1.01	2.68
48	2.74	1.19	.716	8.52×10^{12}	2.26

TABLE IIB. - THE EXPECTED CURRENT AT THE DETECTOR

DUE TO AEROSOL BACKSCATTER

Z	N_{Mie} (m^{-3})	$\frac{N_{Mie}}{Z^2}$ (m^{-5})	q^2	$\frac{q^2 N_{Mie}}{Z^2}$ (m^{-5})	$i_{Mie-det}$ (amperes)
1	1.15	1.15×10^{2}	.835	9.60×10^{1}	1.41×10^{1}
2	2.95×10^{7}	7.38	.792	5.84	8.60×10^{-1}
3	8.0×10^{6}	8.89×10^{-1}	.779	6.93×10^{-1}	1.02×10^{-1}
4	2.15	1.34×10^{-1}	.771	1.03×10^{-1}	1.52×10^{-2}
5	8.0×10^{5}	3.20×10^{-2}	.768	2.46×10^{-2}	3.62×10^{-3}
6	6.5	1.81×10^{-2}	.762	1.38×10^{-2}	2.03×10^{-3}
7	5.5	1.12×10^{-2}	.759	8.50×10^{-3}	1.25×10^{-3}
8	3.5	5.47×10^{-3}	.753	4.12×10^{-3}	6.06×10^{-4}
9	2.5	3.09×10^{-3}	.750	2.32×10^{-3}	3.42×10^{-4}
10	3.5	3.50×10^{-3}	.748	2.62×10^{-3}	3.86×10^{-4}
11	5.0	4.13×10^{-3}	.746	3.08×10^{-3}	4.53×10^{-4}
12	7.5	5.21×10^{-3}	.743	3.87	5.70×10^{-4}
13	1.0×10^{6}	5.92×10^{-3}	.741	4.39	6.46×10^{-4}
14	1.25	6.38×10^{-3}	.738	4.71	6.93×10^{-4}
15	1.5	6.67×10^{-3}	.734	4.90	7.21×10^{-4}
16	1.7	6.64×10^{-3}	.734	4.87	7.17×10^{-4}

TABLE IIB. - cont.

Z	N_{Mie} (m^{-3})	$\frac{N_{Mie}}{Z^2}$ (m^{-5})	q^2	$\frac{q^2 N_{Mie}}{Z^2}$ (m^{-5})	$i_{Mie\text{-}det}$ (amperes)
17	3.3	1.14×10^{-3}	.731	8.33×10^{-4}	1.23×10^{-4}
18	2.5	7.72×10^{-3}	.729	5.63×10^{-3}	8.29×10^{-4}
19	1.75	4.85×10^{-3}	.726	3.52×10^{-3}	5.18×10^{-4}
20	1.25	3.13×10^{-3}	.726	2.27×10^{-3}	3.34×10^{-4}
21	1.05	2.38×10^{-3}	.724	1.72×10^{-3}	2.53×10^{-4}
22	8.0×10^{5}	1.65×10^{-3}	.723	1.19×10^{-3}	1.75×10^{-4}
23	7.0	1.32×10^{-3}	.721	9.52×10^{-4}	1.40×10^{-4}
24	6.5	1.13×10^{-3}	.721	8.15×10^{-4}	1.20×10^{-4}
25	6.0	9.60×10^{-4}	.721	6.92×10^{-4}	1.02×10^{-4}
26	5.0×10^{5}	7.40×10^{-4}	.719	5.32×10^{-4}	7.83×10^{-5}

TABLE III. - THE VOLTAGE AT THE DETECTOR TIMES THE SQUARE OF THE ALTITUDE FOR AEROSOL AND MOLECULAR BACKSCATTER

Z	$Z^2V_{R_2}$ (Volt-m^2)	Z^2V_{Mie} (Volt-m^2)	$Z^2V_{(R+Mie)}$ (Volt-m^2)
1	2.56×10^8	7.05×10^8	9.61×10^8
2	2.2×10^8	1.72×10^8	3.92
3	1.96×10^8	4.59×10^7	2.42
4	1.74	1.22×10^7	1.86
5	1.56	4.53×10^6	1.61
6	1.39	3.67	1.43
7	1.24	3.06	1.27
8	1.09	1.94	1.11
9	9.72×10^7	1.39	9.86×10^7
10	8.55	1.93×10^6	8.74
11	7.50	2.75×10^6	7.78
12	6.41	4.10	6.82
13	5.46	5.46	6.01
14	4.66	6.80	5.34
15	3.94	8.12	4.75
16	3.38	9.19	4.30
17	2.86	1.78×10^7	4.64
18	2.45	1.34	3.79
19	2.08	9.35×10^6	3.02
20	1.78	6.68	2.45
21	1.51	5.60	2.07
22	1.29	4.24	1.71
23	1.10	3.70	1.47
24	9.33×10^6	3.46	1.28

TABLE III. - cont.

Z	Z^2V_R (Volt-m^2)	Z^2V_{Mie} (Volt-m^2)	$Z^2V_{(R+Mie)}$ (Volt-m^2)
25	8.00×10^6	3.19×10^6	1.12
26	6.76	2.65×10^6	9.41×10^6
27	5.80		
28	4.98		
29	4.25		
30	3.65		
31	3.11		
32	2.68		
33	2.29		
34	1.95		
35	1.68		
36	1.44		
37	1.23		
38	1.07		
39	9.13×10^5		
40	7.90		

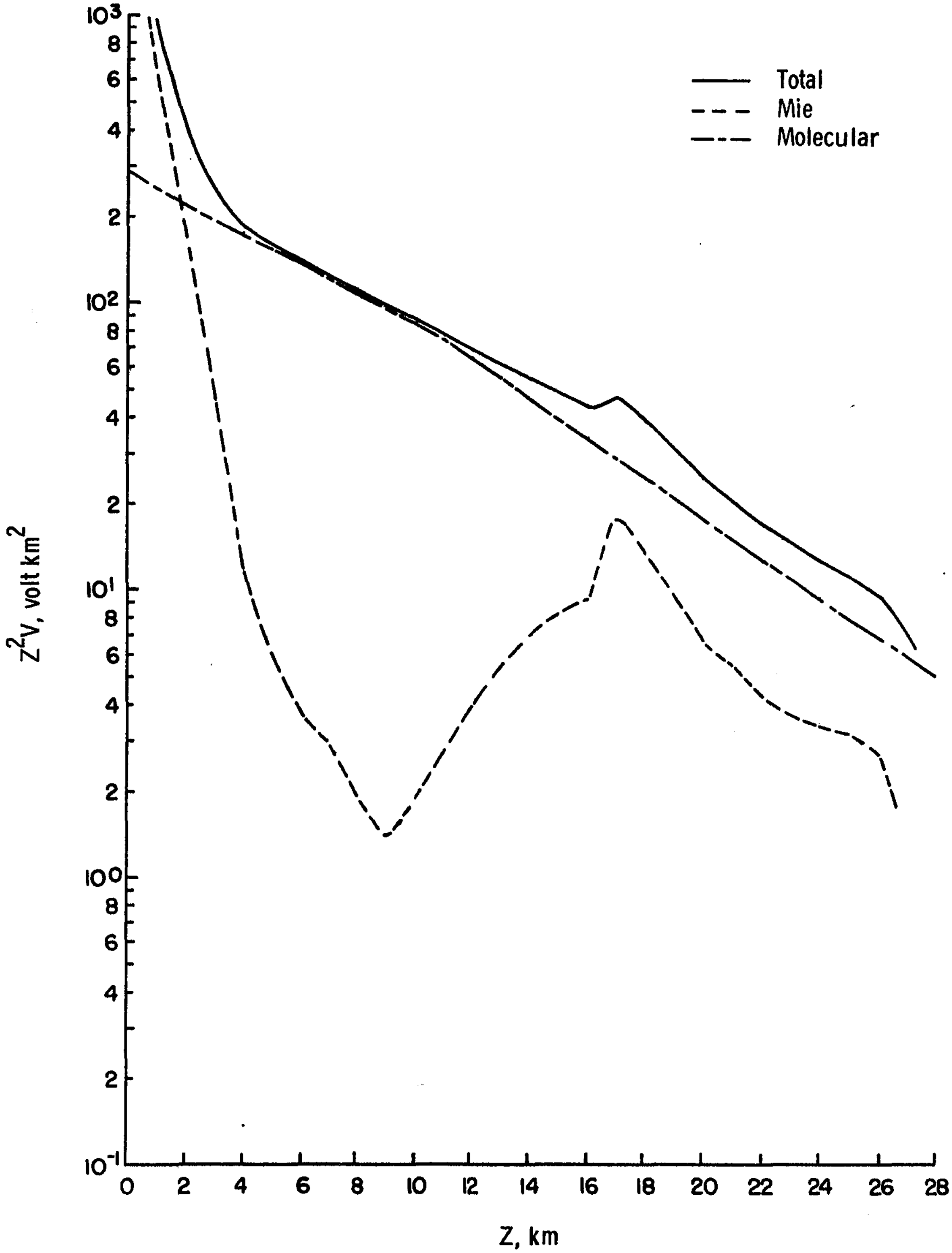

Figure 6.- The voltage times the square of the altitude versus altitude for molecular and aerosol (model I) backscatter. The sum is shown also.

The results of a computer program (given in Appendix IV) to compute single particle intensity functions for arbitrary index, real or complex, are tabulated in Appendix II for $\alpha = 0.01(0.01)2$ and $2(0.1)180$, $\eta = 1.5$, and $\theta = 180^{\circ}$. Integrals of the single particle functions for backscatter over the Junge size distribution have been calculated numerically for $\nu = 2.5$, 3.0, 3.5, and 4.0; $\Delta\alpha = 0.1$, 0.2, and 0.5; $\alpha_1 = 0.04$, 0.06, 0.08, 0.1μ, and $\alpha_2 = 3$, 5, 10μ. These values are tabulated in Appendix III. The computations, as discussed previously, indicate that Φ for backscatter is very sensitive to the choice of lower limit but not to the upper limit.

Equation (16) suggests a natural extension of the experiment to laser wavelengths other than the ruby wavelength. If the scattering cross section of the atmosphere was measured almost simultaneously at two laser wavelengths λ_1 and λ_2, equation (16) gives the ratio

$$\frac{\sigma_{Mie}(\lambda_1)}{\sigma_{Mie}(\lambda_2)} = \left(\frac{\lambda_2}{\lambda_1}\right)^{\nu-2} \frac{\Phi(\lambda_1)}{\Phi(\lambda_2)}$$

The ratio has been calculated (table IV) for the following laser wavelengths: 0.3472μ (2nd harmonic of ruby), 0.5300μ (2nd harmonic of Nd doped glass), 0.6943μ (ruby), 1.06μ (Nd doped glass), and is plotted in figure 7. Φ has been calculated for a lower particle size limit of 0.04μ and an upper size limit of 10μ in all cases.

The actual signal measured at the detector can be computed as shown in Sections IIa and IIb by measuring at both laser wavelengths the mirror reflectivity and area, laser output energy, filter response and photomultiplier quantum efficiency and gain. The mirror reflectivity,

TABLE IV. - THE RATIO OF THE ABSOLUTE BACKSCATTER CROSS-SECTION AT TWO WAVELENGTHS

λ_1	λ_2	ν 2.5	3	3.5	4
1.06	.6943	.8091	.6512	.5370	.4457
1.06	.5300	.6721	.498	.3653	.273
1.06	.3472	.5365	.3344	.2091	.1379
.6943	.5300	.8306	.7648	.6802	.6123
.5300	.3472	.7982	.6714	.5730	.5045

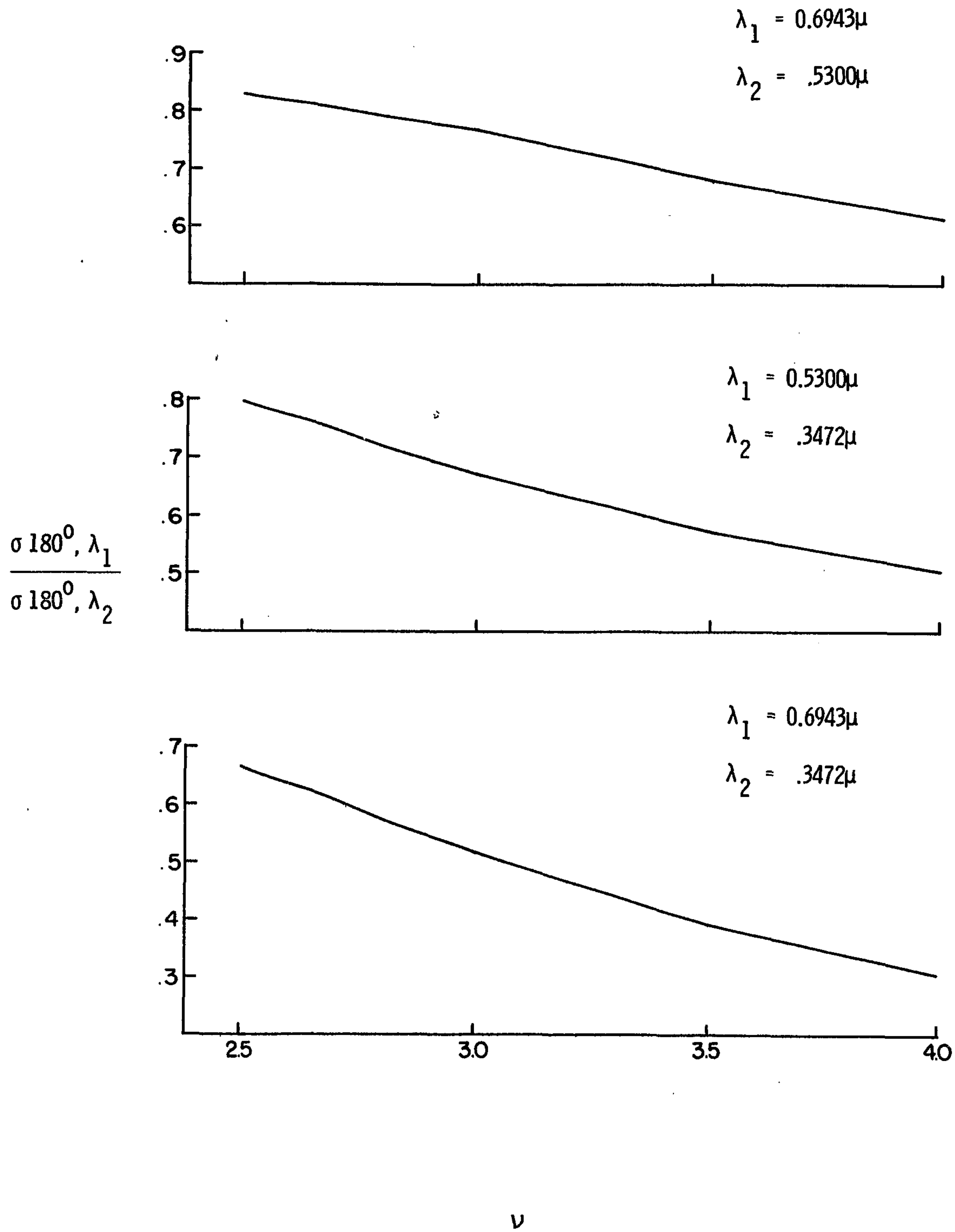

Figure 7(a).- The ratio of the absolute scattering cross section for aerosol backscatter at two wavelengths versus the power of the size distribution.

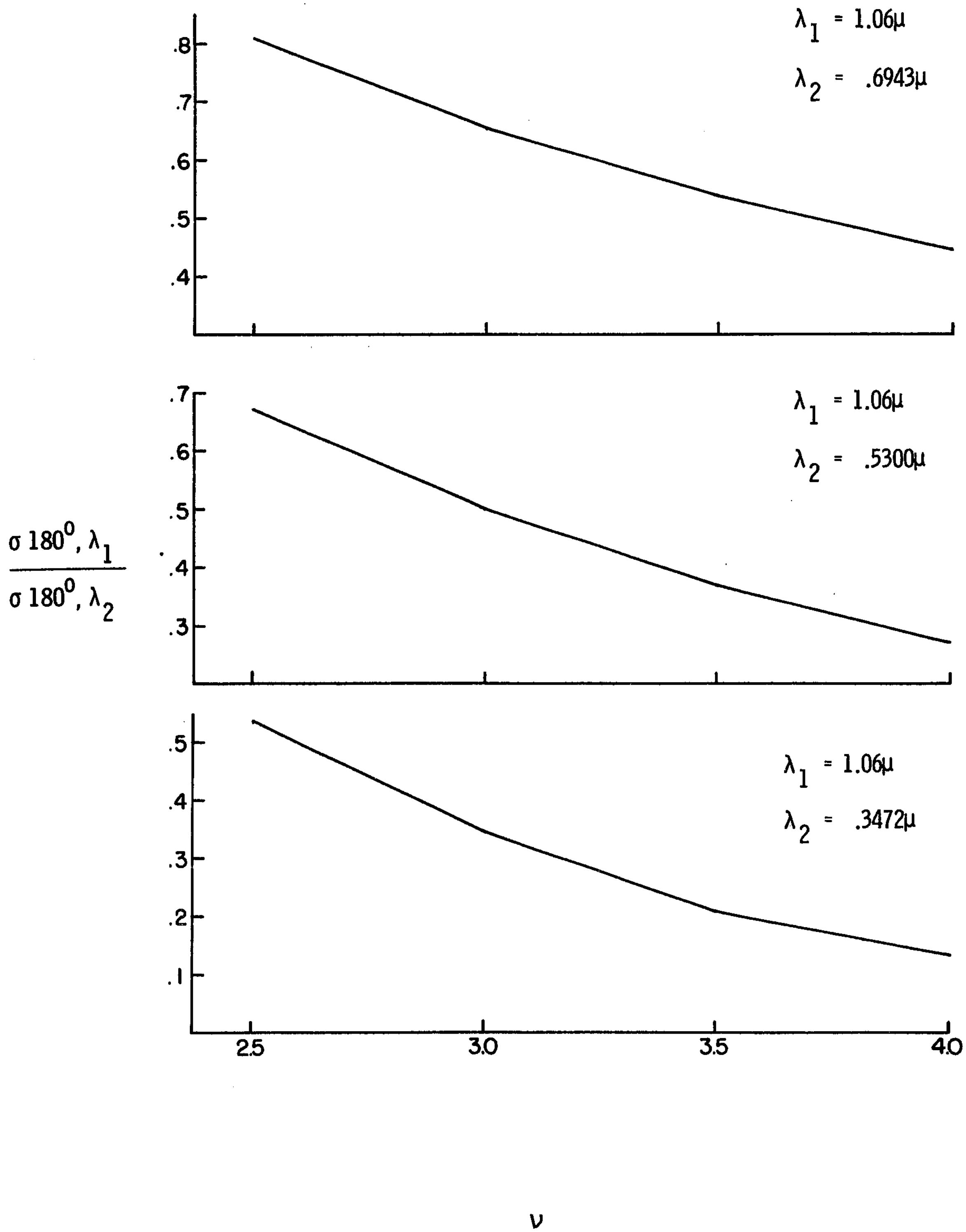

Figure 7(b).- The ratio of the absolute scattering cross section for aerosol backscatter at two wavelengths versus the power of the size distribution.

filter response, photomultiplier quantum efficiency, and gain are known system characteristics and the laser output energy is normally measured for each transmission. The absolute value of these parameters would not have to be measured individually, however, since they enter equation (5) as a lumped constant which can be measured for each laser wavelength. At 9 km (the isopycnic layer) the molecular number density remains constant to within 1 percent and large particle scattering is negligible. A measurement at the isopycnic layer, therefore gives

$$\frac{V_{det}(\lambda_1, 9\text{ km})}{V_{det}(\lambda_2, 9\text{ km})} = \frac{c(\lambda_1)q^2(\lambda_1)}{c(\lambda_2)q^2(\lambda_2)} \frac{\sigma_R(\lambda_1)}{\sigma_R(\lambda_2)}$$

where $V_{det}(\lambda_1, 9\text{ km})$ is the voltage at the detector for λ_1 laser radiation scattered from 9 km, and

$$\sigma_R = k^4\bar{\alpha}^2 N_R(Z)$$

Since $N_R(Z)$ is the same for both wavelengths and remains constant

$$\frac{V_{det}(\lambda_1, 9\text{ km})}{V_{det}(\lambda_2, 9\text{ km})} = c_{12}\left(\frac{k_1}{k_2}\right)^4 \frac{q^2(\lambda_1)}{q^2(\lambda_2)}$$

where $c_{12} = \dfrac{c(\lambda_1)}{c(\lambda_2)}$ and represents the ratio of the system characteristics at wavelengths λ_1 and λ_2. For heights above 9 km, therefore, equations (5) and (16) give

$$\frac{V_{det}(\lambda_1, Z')}{V_{det}(\lambda_2, Z')} = c_{12} \frac{q^2(\lambda_1, 9\text{ km})}{q^2(\lambda_2, 9\text{ km})}$$

$$\frac{\exp\left\{-2\int_9^{Z'}\left[\beta_{Mie}(\lambda_1,Z) + \beta_0(\lambda_1,Z) + \beta_R(\lambda_1,Z)\right]dZ\right\}}{\exp\left\{-2\int_9^{Z'}\left[\beta_{Mie}(\lambda_2,Z) + \beta_0(\lambda_2,Z) + \beta_R(\lambda_2,Z)\right]dZ\right\}}\left[\frac{\sigma_{Mie}(\lambda_1,Z') + \sigma_R(\lambda_1,Z')}{\sigma_{Mie}(\lambda_2,Z') + \sigma_R(\lambda_2,Z')}\right]$$

Since virtually all attenuation of both laser transmissions takes place in the first 9 km, the above equation can be written

$$\frac{V_{det}(\lambda_1,Z)}{V_{det}(\lambda_2,Z)} = \left(\frac{k_2}{k_1}\right)^4 \left[\frac{V_{det}(\lambda_1,9\ \mathrm{km})}{V_{det}(\lambda_2,9\ \mathrm{km})}\right] \left[\frac{\sigma_{Mie}(\lambda_1,Z) + \sigma_R(\lambda_1,Z)}{\sigma_{Mie}(\lambda_2,Z) + \sigma_R(\lambda_2,Z)}\right]$$

It is clearly evident from this equation that measurements at three wavelengths will uniquely determine a two-parameter aerosol model atmosphere. Measurements at two laser wavelengths would severely limit the range of parameters consistent with experimental measurement, and when considered in conjunction with the direct measurement of total aerosol number density would provide a method for observing changes in particle size distribution.

III. NOISE CONSIDERATIONS

Noise in the system originates from the signal, background, photomultiplier, and load resistor. This includes shot noise associated with signal, background, and photomultiplier dark current given by

$$i_N = \mu(2ei\ \Delta f)^{1/2} = \mu\left[2e(i_D + i_S + i_B)\Delta f\right]^{1/2} \tag{24}$$

where

i_D = dark current of the photomultiplier at the photocathode

i_S = signal current at the photocathode

i_B = background current at the photocathode

μ = gain of the photomultiplier

e = electron charge

Δf = passband of the measuring instrument

and the Johnson (thermal) noise associated with the load resistor, given by

$$i_{JN} = \frac{(4kTR\ \Delta f)^{1/2}}{R} \tag{25}$$

where

k = Boltzmann's constant

T = absolute temperature

R = value of the load resistor

Neglected in equation (24) is the noise associated with the thermionic emission from the dynodes. However, since the gain per stage is of the order of 4 or 5, this additional noise amounts only to a small increase in equation (24). The randomness of the secondary emission at the dynodes adds additional noise also equivalent to multiplying equation (24) by a factor of 1.2[32].

The thermal noise contribution is negligible compared to shot noise as can be seen by comparing equation (24) and equation (25). Any signal current greater than 10^{-18} amperes (6 electrons sec^{-1}) makes the shot noise greater than the Johnson noise for a load resistor of 100 Ω. Ignoring the Johnson noise and the randomness of the secondary emission, the signal-to-noise ratio is given by

$$S_N = \mu \frac{i_S}{i_N} = \frac{i_S}{\left[2e\ \Delta f(i_S + i_B + i_D)\right]^{1/2}} \tag{26}$$

S_N can be increased by increasing i_S, decreasing Δf, or decreasing $(i_B + i_D)$. The system may be optimized by the correct choice of these parameters. Solving equation (26) for i_S,

$$i_S = (e\ \Delta f)S_N^{\,2} + \left[(e\ \Delta f)^2\ S_N^{\,4} + 2(e\ \Delta f)S_N^{\,2}\ (i_B + i_D)\right]^{1/2} \tag{27}$$

We shall accept $S_N = (10)^{1/2}$ as a minimum S_N for signal detection. A plot of i_S versus Δf for $S_N = (10)^{1/2}$, and $(i_B + i_D) = 0,\ 10^{-14}$, and 10^{-11} amperes is given in figure 8. These values represent the extreme cases of no dark current or background, maximum dark current and no background, and maximum dark current and maximum background. The minimum resolution $\frac{c\tau}{2}$ corresponding to each bandwidth is given on the top margin, and the maximum height corresponding to the calculated current expected for Rayleigh scattering is given on the right margin. Several important conclusions can be reached by examining these curves.

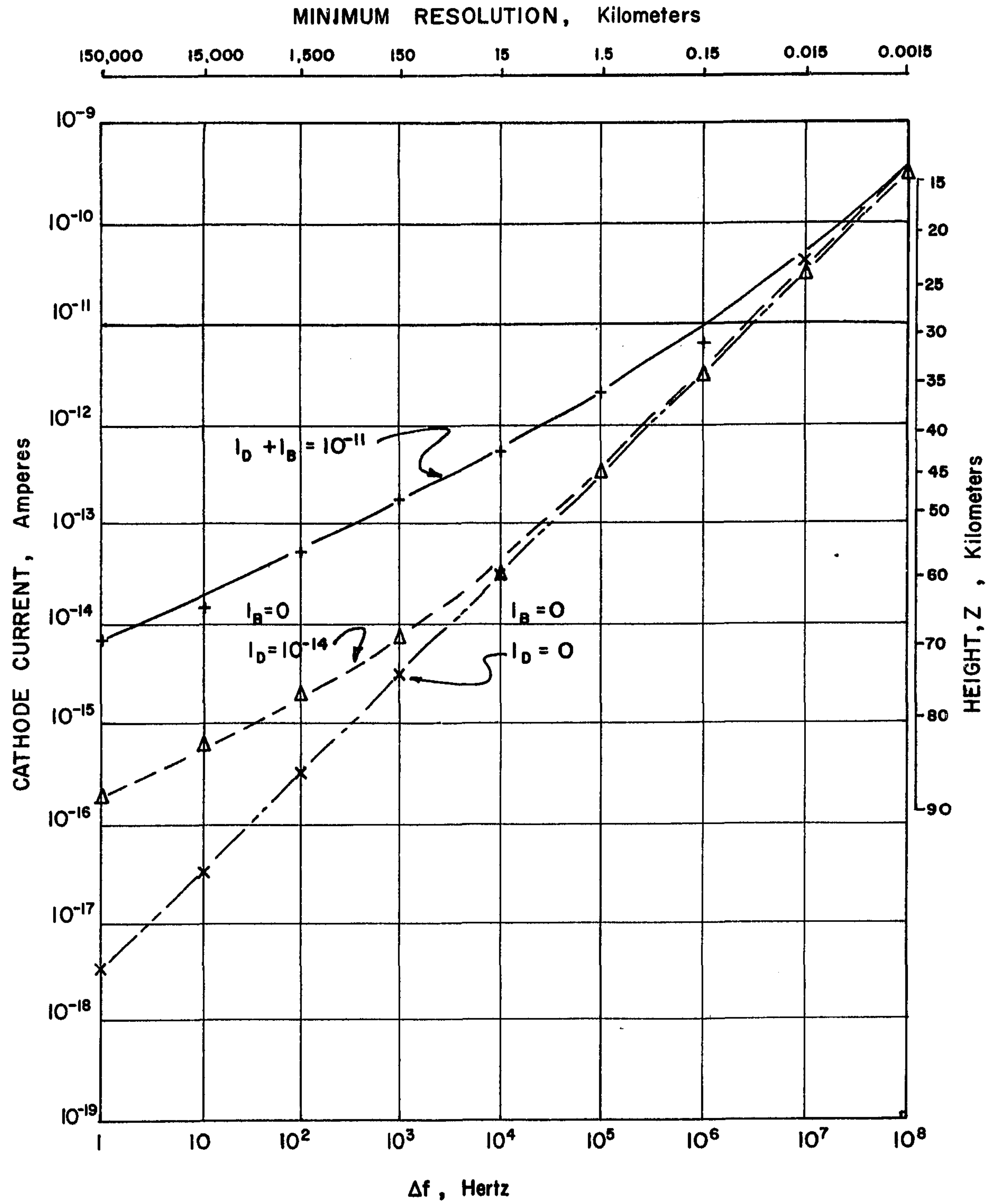

Figure 8.- A plot of the minimum detectable cathode current versus bandwidth for various values of background and dark current. The altitude of return is based on a molecular atmosphere.

(1) For $\Delta f \geq 10^8$ cps, the limiting factor is the shot noise produced by the signal. Reducing the background and dark current to zero will not allow a smaller signal to be detected.

(2) Decreasing the bandwidth to 10^5 cps and reducing the background level below that of the dark current will allow heights of up to 45 km to be investigated. Lowering the dark current will not allow a smaller signal to be detected.

(3) Lowering the bandwidth below 10^4 cps would destroy the height resolution of the system.

To compute the sky background noise, the average sky background power P_B incident on the receiver must be calculated.

$$P_B = \Omega A_R q_R \, \Delta\lambda R_\lambda \tag{28}$$

where R_λ is the background radiance in watts m^{-2}steradian^{-1}Å^{-1}, Ω is the solid angle of the receiver in steradians, $\Delta\lambda$ is the passband of the filter and S-20 photocathode response, q_R is the efficiency of the receiving optics, and A_R is the receiver area in m^2. R_λ is given by Ketay(33) for the day sky to be 2×10^{-3} watts^{-2}steradian^{-1}Å^{-1} for the 7000 Å region. Pavlova(34) gives a value of 2×10^{-9} watts^{-2}steradian^{-1}Å^{-1} for the nighttime air glow in the region of 7000 Å. These values agree with the electrometer measurements of the background radiation incident on our system.

As seen in equation (28), this background power may be minimized by limiting the receiver's field of view to that of the transmitter's field of view and/or reducing the passband of the filter system. $\Delta\lambda$ may be reduced by using a very narrow band interference filter chosen so that the highest signal-to-noise ratio is achieved. When using such a filter, the incident light must be rendered parallel to within $\pm 3^{\circ}$. The angle of divergence of the transmitter can be decreased by using a collimator in front of the laser. The angular demagnification is given by

$$D_T = \frac{f_r}{f_e}$$

where f_r is the focal length of the entrance lens and f_e is the focal length of the exit lens. The angle of divergence of the transmitter is given by

$$\delta_T = \frac{f_r}{f_e} \delta_L$$

where δ_L is the angular divergence of the laser. Thus, shot noise due to the background can be decreased by decreasing the angular divergence of the receiver, decreasing $\Delta\lambda$, and increasing the angular demagnification of the collimator.

Another source of background is the fluorescence associated with the laser transmission. The wavelength of this radiation is the same as the giant pulse and, therefore, cannot be discriminated against with the use of filters. The amplitude of the fluorescence is much smaller than the laser pulse, but persists for about 2 milliseconds. Scattering of this fluorescence radiation from the lower atmosphere is comparable to the laser pulse scattering from very high altitudes. For this reason, a rotating shutter has been designed and is described in the equipment section.

The maximum height which can be investigated increases as the bandwidth of the receiving system is decreased. The use of an electronic bandwidth much less than 10^4 cps, however, destroys the height resolution of the system. Thus, a different measurement technique must be used if altitudes much above 50 km are to be investigated.

For measuring the return from high altitudes, it will be necessary to use a photon counting system. With such a system, the number of pulses produced by the emission of photoelectrons is counted and stored in a digital delay line. Stored in the nth "channel" are those pulses occurring during an interval of length l and at a time t_n after the laser emission, t_n being different for each channel. Thus, the number of counts in each channel represents the return from a height interval $\Delta h = \frac{cl}{2}$ about a height $h = \frac{ct_n}{2}$. The advantage of this system is that the signal-to-noise ratio can be improved with no loss of resolution by taking the total number of counts in each channel produced by a number of successive shots.

The number of counts in any time interval obeys a Poisson distribution; therefore, the standard deviation is $\sqrt{\bar{C}t}$ where $\bar{C}$ is the mean number of counts per unit time during the interval and t is the total counting time. Thus, the signal-to-fluctuation ratio is

$$S = \frac{tC_S}{\left[t(C_S + C_D + C_B)\right]^{1/2}} \tag{29}$$

where C_S, C_D, and C_B are the number of counts per unit time due to signal, dark current, and background, respectively, and t is the total counting time. It is seen that $S \rightarrow t^{1/2}$, so that increasing t increases S. If the system is fired N times and the number of counts in one channel are collected for an interval l for each shot, then the total counting time is $t = Nl$, while the resolution is $\frac{cl}{2}$. Thus, increasing N increases S with no change in the resolution of the system.

Let us now consider the minimum signal that can be detected with such a system. Solving for C_S gives

$$C_S = \frac{S^2}{2t}\left\{1 + \left[1 + \frac{4t}{S^2}(C_D + C_B)\right]^{1/2}\right\} \tag{30}$$

If $S^2 = 10$ (by analogy with the discussion given for equation (27) and figure 8), we get the minimum counting rate which can be detected with a given counting time.

$$C_S = \frac{5}{t}\left\{1 + \left[1 + \frac{2t}{5}(C_D + C_B)\right]^{1/2}\right\} \tag{31}$$

A plot of C_S versus t for values of $(C_D + C_B) = 0,\ 0.6 \times 10^5\ \text{sec}^{-1}$, and $0.6 \times 10^8\ \text{sec}^{-1}$ (corresponding to values of $(i_D + i_B) = 0,\ 10^{-14}$ amp, and 10^{-11} amp) is given in figure 9. From this curve, it is possible to determine the approximate height from which return from molecular scatter can be measured, using the calculated values of the Rayleigh scattering return signal. Figure 9 shows that if an ideal system with background and dark current equal to zero is assumed, a counting time of 10^{-5} sec would allow a counting rate of 10^6 counts sec^{-1} to be measured. This corresponds to a return from approximately 49 km. If 10 successive shots with $l = 10^{-5}$ sec are taken, then $t = 10^{-4}$ sec, and the maximum height

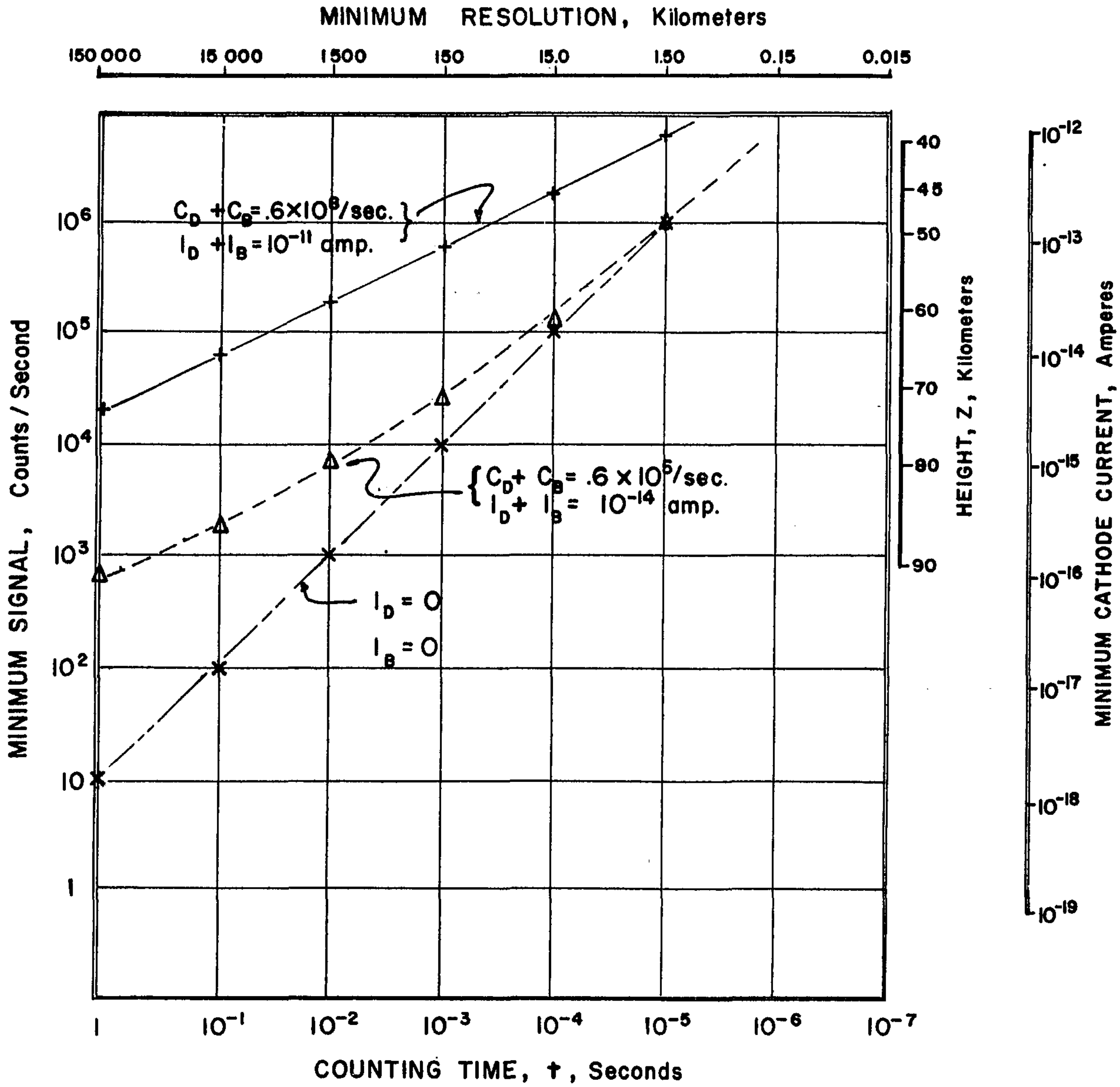

Figure 9.- A plot of the minimum counting rate versus counting time for various values of background and dark count. The altitude of return is based on a molecular atmosphere.

from which return can be measured is approximately 63 km, while the resolution remains at 1.5 km. Similarly, if 10 shots with $\tau = 10^{-4}$ sec (15 km resolution) are taken, then return from 77 km can be measured. Greater altitudes can be reached by taking a larger number of shots.

It is apparent from the curve that if return from above 50 km is to be measured, then not only should the background be made as low as possible, but also that it will be beneficial to reduce the dark current of the photomultiplier tube. For example, if $t = 10^{-3}$ sec, the reduction of the dark current from its normal 0.6×10^5 photoelectrons sec^{-1} to less than 10^3 photoelectrons sec^{-1} will increase the maximum height by about 7 km, with greater reductions in height possible for longer counting times. Note, however, that the background must be lower than the dark current if the effect is to be this large. By cooling the photomultiplier tube, it is possible to reduce the dark current to the order of 200 photoelectrons sec^{-1}, which makes this source of noise in these experiments negligible.

IV. EQUIPMENT

General

The basic experimental arrangement is shown in figure 10. The laser pulse is monitored with a set of beam splitters whose axes are separated by 90°, allowing a portion of the beam to fall on a diffuse white screen which lies in the field of view of a photodiode. The beam splitters' orientation provides polarization insensitivity. The output of the photodiode is displayed on a Tektronix 585 oscilloscope and provides a measure of the laser pulse width. The charge through the photodiode gives a number proportional to the total number of emitted photons and the total light energy. This charge is stored in a capacitor and the resulting voltage measured by an electrometer giving an energy readout to within ±10 percent. The focus electrode of the photomultiplier detector is biased 30 V negative with respect to the cathode, thereby defocusing the tube. A monostable multivibrator (see fig. 11) is triggered by a delayed pulse synchronous with the emission of the giant laser pulse. The monostable multivibrator produces a positive gate with a rise time of about 1 μsec and a variable width and height. This gate is applied to the focusing electrode, thereby focusing the detector for a length of time determined by the gate width. The anode of the photomultiplier is direct coupled to a variable gain operational amplifier used to limit the frequency passband of the system. This output is direct coupled to an amplifier with logarithmic response over 3 decades and displayed, simultaneously with the gating waveform, on a dual-beam oscilloscope. An alternative to this configuration is to direct couple the photomultiplier

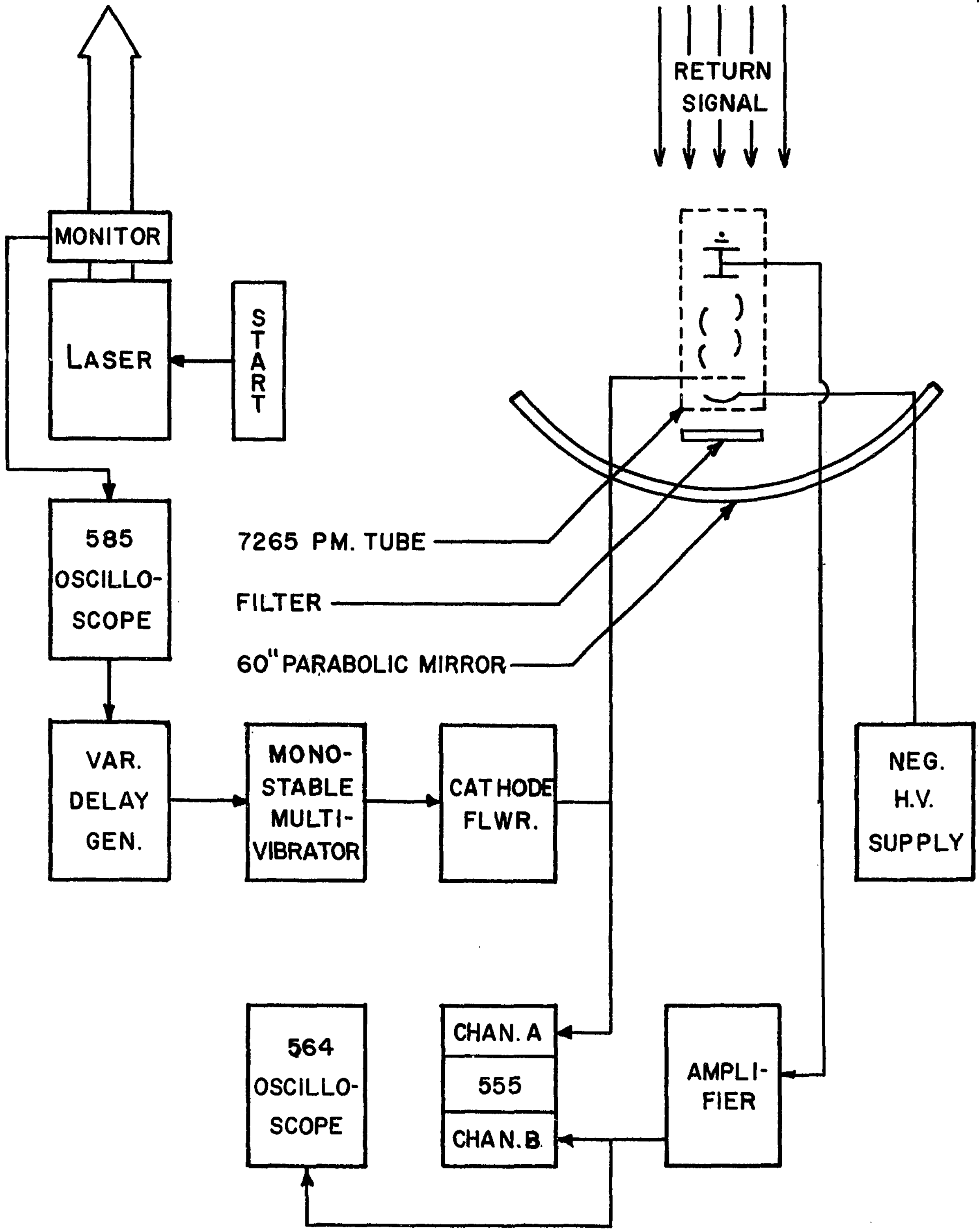

Figure 10.- A block diagram of the experimental arrangement.

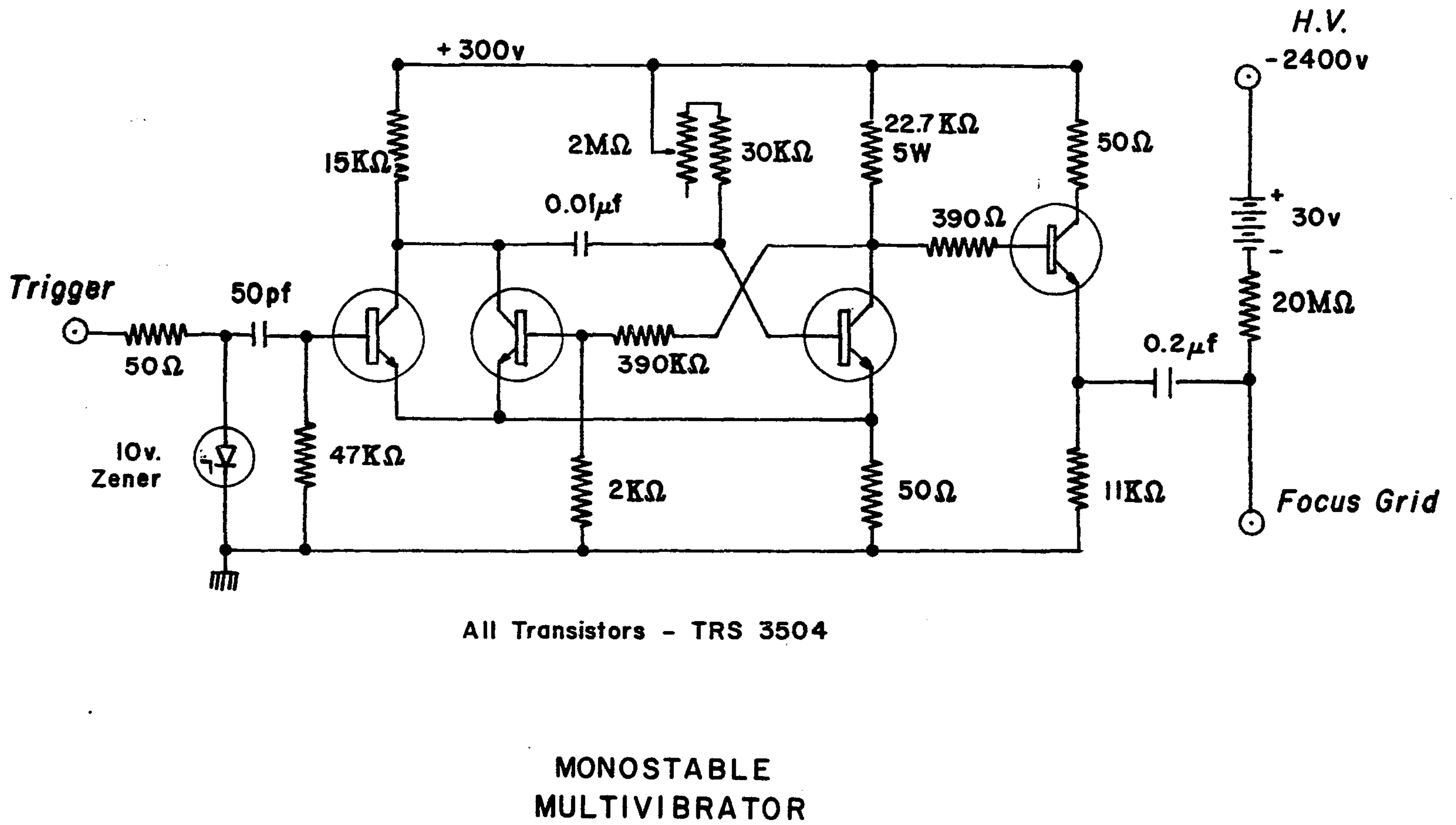

Figure 11.- Monostable multivibrator.

to a linear amplifier displaying the two linear amplifier outputs at different sweeps and sensitivities. The voltage range which can be measured with a Tektronix 555 oscilloscope is about two orders of magnitude. This technique has proved to facilitate quantitative measurements. Figure 12 shows the triggering sequence as it evolves in time.

IVa. Receiver System

The receiver system consists of a 60-inch searchlight mirror (focal length = 25.54 inches) in a steerable mount. The photomultiplier detector is positioned behind the focal plane on a precision mount with five degrees of freedom. An iris is used to limit the field of view of the mirror to a calculated value of about 8 milliradians. In order to limit the night-sky background, a Wratten No. 70 filter is positioned in front of the photomultiplier. This filter has a sharp cutoff at 6500 Å and, when used in conjunction with a photomultiplier having an S-20 photocathode spectral response, gives a bandpass of about 700 Å. Several methods of incorporating a narrow band interference filter into this system have been studied. A wide-angle plastic doublet lens with an index of 1.49 and a transmittance of 75 percent was studied with a ray trace program and calculated to collimate the radiation from 50 percent of the mirror surface to within $\pm 3^{\circ}$ which would permit the use of a 20 Å interference filter. In view of the quality of the searchlight mirror surface, it is difficult to attach a great deal of significance to such calculations, although the method does show some promise of improving the signal-to-noise ratio.

IVb. Transmitter System

Two lasers have been incorporated into the system in order to provide measurements at two wavelengths nearly simultaneously. One of

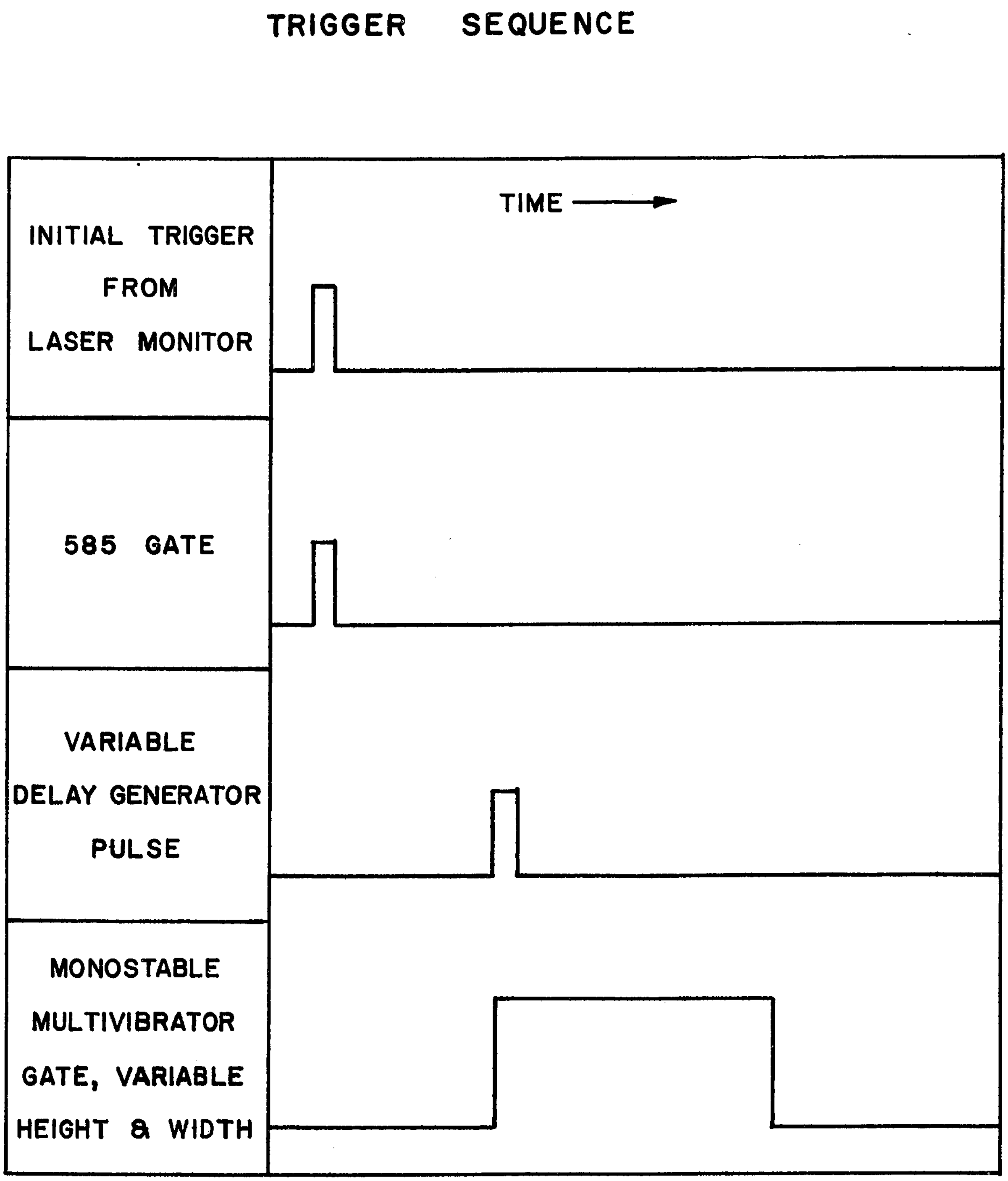

Figure 12.- Trigger sequence.

these laser systems can be operated with a 4-inch by 9/16-inch ruby rod or a 6-inch by 3/8-inch neodymium rod. The ruby rod is Q-switched with a cryptocyanine-methanol solution giving an energy output of about 2 joules; the neodymium rod is Q-switched with Kodak 9740 dye-chlorobenzene solution and yields an energy output of about 0.8 joule. The second laser system contains a 7-inch by 1/2-inch Brewster angle ruby rod which is Q-switched by uranyl glass and has an energy output of about 2 joules. These laser systems when used in conjunction with a frequency doubling cell of potassium dihydrogen phosphate give the capability of operating at three usable wavelengths: 0.53μ, 0.6943μ, and 0.3472μ. The neodymium fundamental at 1.06μ will be of little use because of the lack of a suitable photodetector for this wavelength. Each laser is enclosed in a light-tight container with a monitor positioned at the output and are temperature controlled in order to prevent detuning into a water vapor absorption line. The water vapor absorption bands correspond to a ruby temperature of 15° C and 35° C.

To assist in the alignment of the receiver and transmitter, a telescope has been aligned with the axis of the laser. The back beam of a gas laser is directed into the ruby or neodymium laser cavity and the reflected beam is made coincident with it. The output beam of the gas laser will therefore indicate the direction of the giant pulse. This beam is aligned with a telescope mounted on the laser table and, once this alignment is completed, the telescope is used to align the laser with the receiver axis. This is accomplished by positioning the image of the moon on the focal point of the mirror while simultaneously viewing the moon through the telescope. Final alignment is accomplished by adjusting the axis of the laser for maximum return.

Some measurements have been made with a high-speed rotating shutter. A 400-cycle hysteresis synchronous motor is used to rotate a balanced aluminum disk at 13,200 rpm. A magnetic pickup positioned near the disk provides a pulse to trigger the laser. This pulse is delayed so that the shutter opening aligns itself with the laser exit port when the laser Q-switches. The shutter closes in 115 μsec (17.2 km); therefore, if the laser fires as the shutter begins to close, no fluorescence can enter the receiver after 115 μsec or 17.2 km. Below this height the backscattered laser pulse signal is much greater than the scattered fluorescence. Thus, the rotating shutter is a necessary part of the transmitter when altitudes higher than approximately 30 km are to be studied.

V. EXPERIMENTAL RESULTS

After the laser is fired, the return signal is measured as a function of time by a photomultiplier whose output can be displayed with both logarithmic and linear amplification on a dual-beam oscilloscope. If desired, the gating waveform may replace one of these output signals. No attempt has been made at this point in the experiment to count photons. The bandwidth of the receiving system is limited by a variable gain operational amplifier and the optical efficiency may be reduced by neutral density filters to prevent detector saturation.

Va. Comparison of Experiment With Model Aerosol Atmosphere

Typical observations of the clear atmosphere are plotted in figures 13 and 14. Figure 13 shows a composite of experimental results from shots No. 20, 24, and 31 of March 9, 1967, and figure 14 shows a composite of experimental results from shots No. 1, 7, 9, and 11 of March 18, 1967. The solid curve in each figure represents the calculated total return from the Model I atmosphere; the dashed curve represents the calculated return due to molecular scattering only.

A fast decrease in aerosol number density in the first 2 kilometers is evident; in this region the scattering is predominantly of aerosol origin. The scattering from about 2.5 to 12 kilometers is predominantly of molecular origin; small increases in the absolute cross section, however, are noted throughout, indicating the presence of local concentrations of aerosols. A deviation from molecular scattering appears at about 12 kilometers; the deviation increases to about a factor of two at 19 kilometers.

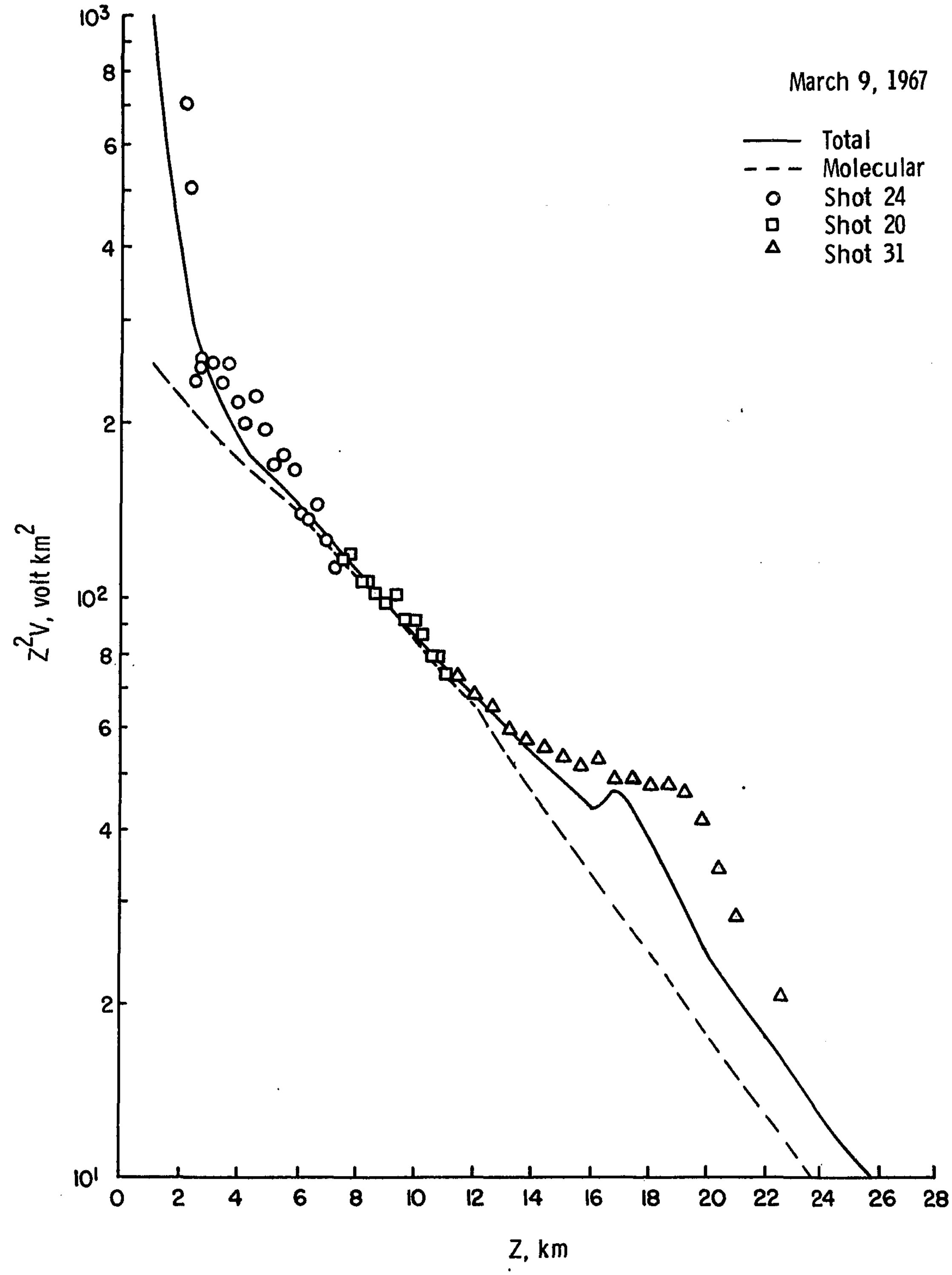

Figure 13.- The voltage times the square of the altitude versus altitude for shots 20, 24, and 31 of March 9, 1967.

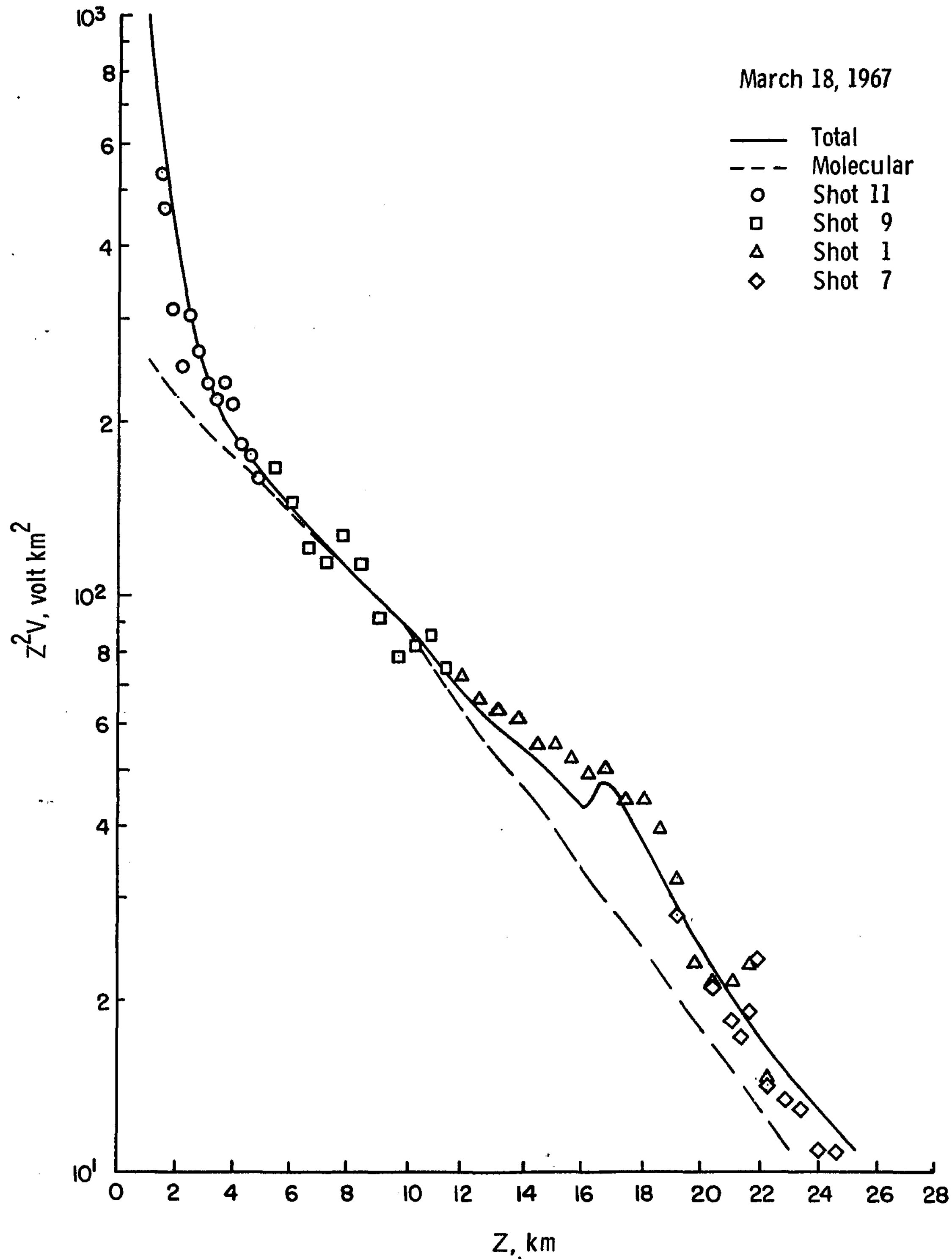

Figure 14.- The voltage times the square of the altitude versus altitude for shots 1, 7, 9, and 11 of March 18, 1967

Figure 15 shows the region 12 to 25 kilometers for two other nights of observation (March 1 and 17, 1967). The deviation from molecular scattering in this region is again evident. An anomalous enhancement, however, appears at about 18.6 kilometers. This increase was correlated with a temperature inversion at the same altitude, and will be discussed later in this section. An anomalous enhancement appeared also on March 18 at 21.6 kilometers. No radiosonde temperature profile was available.

Since the Model Aerosol Atmospheres developed do not include the effect of temperature inversions on the aerosol distribution, these enhancements have been subtracted from the average data plotted in figure 16. The ratio of the experimentally determined relative backscattered power to the backscattered power for the molecular atmosphere is given in figure 17. This ratio, and therefore the deviation from molecular scattering, reaches a maximum of 1.83 at about 18.5 kilometers. The existence of this maximum indicates that the aerosol number density has a relative maximum at 18.5 km which is in general agreement with Model I, but not Model II.

An examination of figures 4 and 5 shows that Model I has a relative maximum in the 12 to 20 km region, whereas Model II does not. Both of these models have assumed $\nu = 3$; however, regardless of choice of ν (as is evident from an examination of equation (16) and Appendix III), Model II cannot correctly predict the experimentally determined scattering cross sections for this region.

Vb. <u>Simultaneous Airborne and Ground-Based Experiment</u>[35]

Simultaneous measurements of the first 12 kilometers of the atmosphere were performed by the William and Mary ground-based system and an

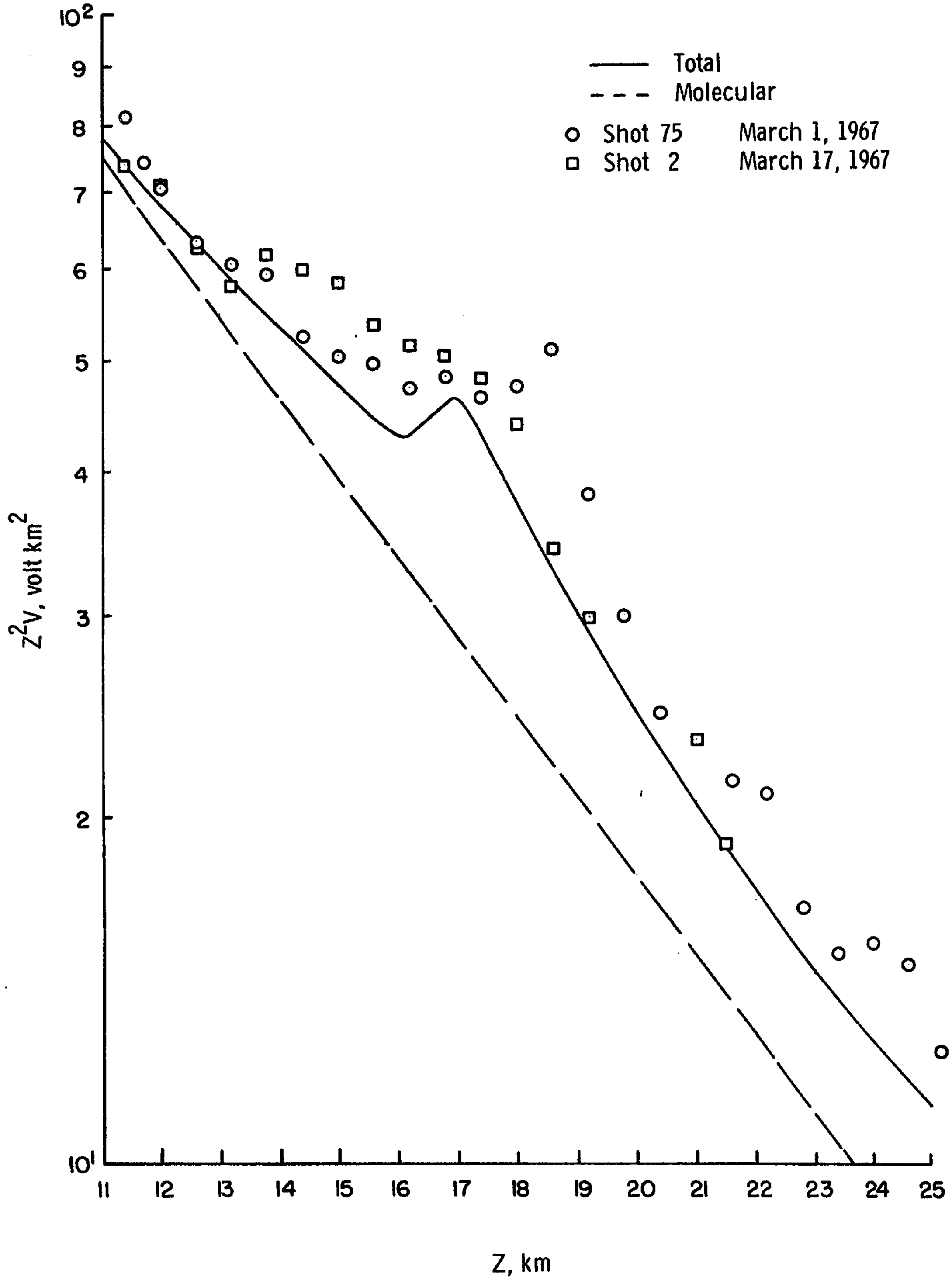

Figure 15.- The voltage times the square of the altitude versus altitude for shot 7 of March 1, 1967, and shot 2 of March 17, 1967.

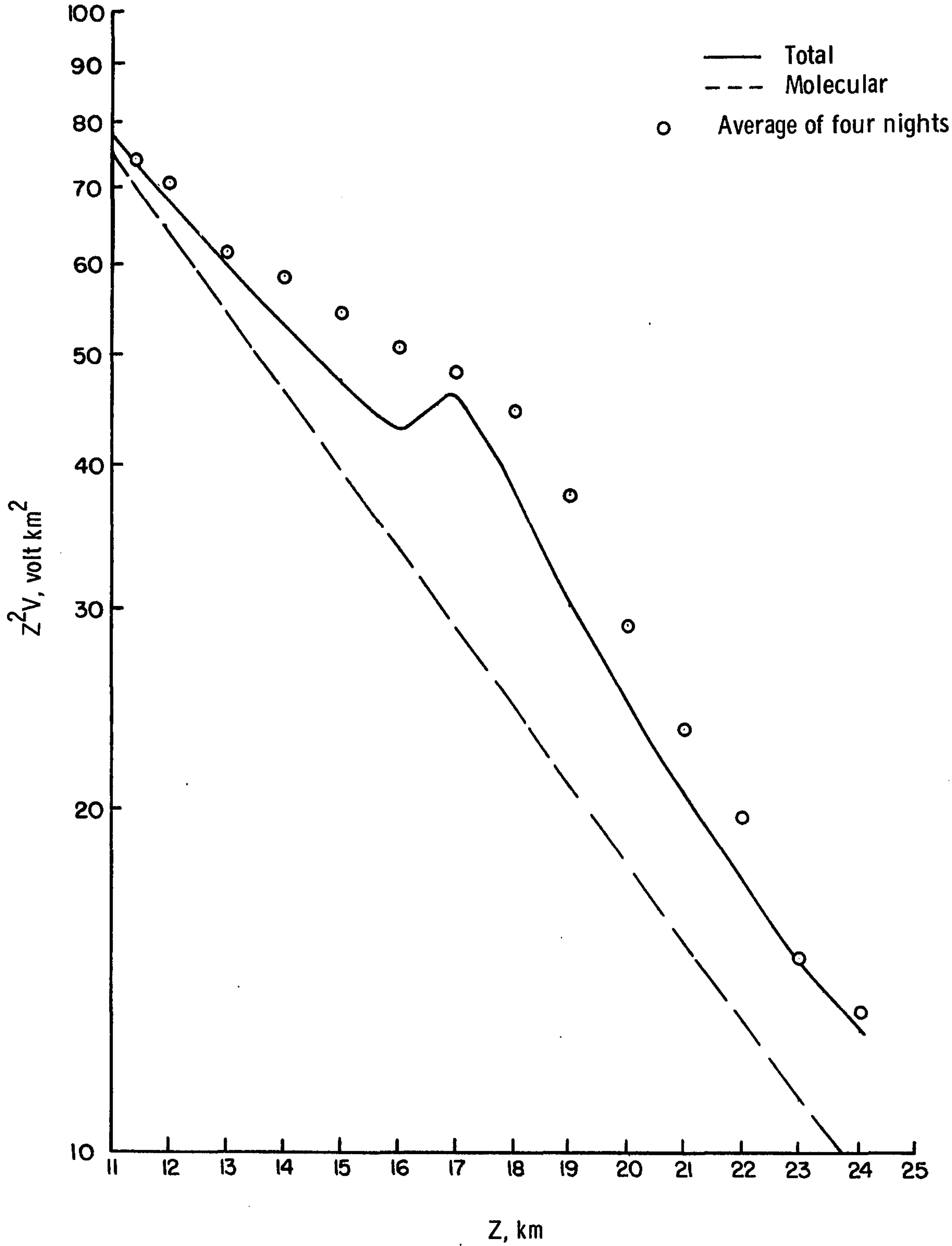

Figure 16.- The average data of four nights,
March 1, 9, 17, and 18.

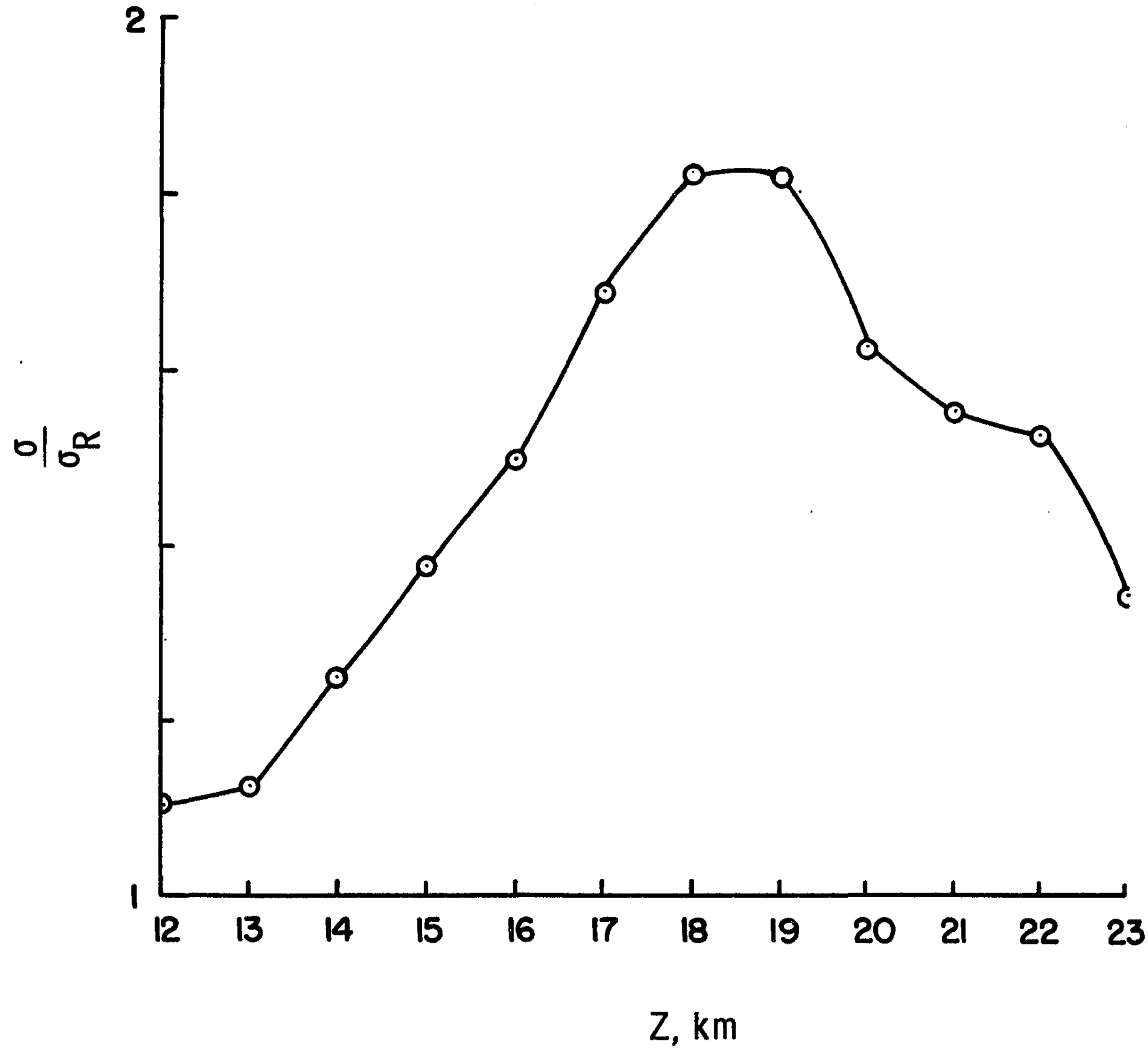

Figure 17.- The ratio of the experimental absolute cross section to the molecular cross section versus altitude for the average data of figure 16.

airborne laser radar system operated by NASA Langley. These systems were used to obtain independent measurements of the absolute cross section of the lower troposphere over Williamsburg on the night of G.m.t. March 10, 1967. The measurements corroborated each other and generally agreed with both model atmospheres.

The airborne system installed in a T-33 type jet aircraft consists of a ruby laser transmitter and a refracting telescope receiver whose axes are aligned parallel. The laser produces pulses of approximately 0.1 joule energy and of 20 nsec duration with a beam divergence of 1 mrad. The backscattered laser energy is collected by a receiver which has a field of view of 3 mrad and an effective collecting aperture of 0.1 meter. The optical bandwidth of the receiving system is determined by a temperature controlled interference filter with a spectral bandwidth of 11.75 Å centered at 6943 Å. The photomultiplier detector used in this system has 16 amplifying stages and a photocathode with an S-20 response.

During the coordinated experiment, the aircraft flew at predetermined altitudes in elliptical paths. Contamination of the atmosphere by the jet exhaust was prevented by flying downwind of the ground station. An average cross section at each altitude was determined by firing the laser horizontally in front of the aircraft and recording the output and backscattered energy. The laser output monitor was calibrated by comparison with a thermopile calorimeter and the spectral response of the receiver was determined using a standard lamp; in consequence, the airborne data are considered absolute. Measurements of the absolute cross section were made from 0.3 km to 10.7 km in increments of 0.3 km and are plotted as solid symbols in figure 18.

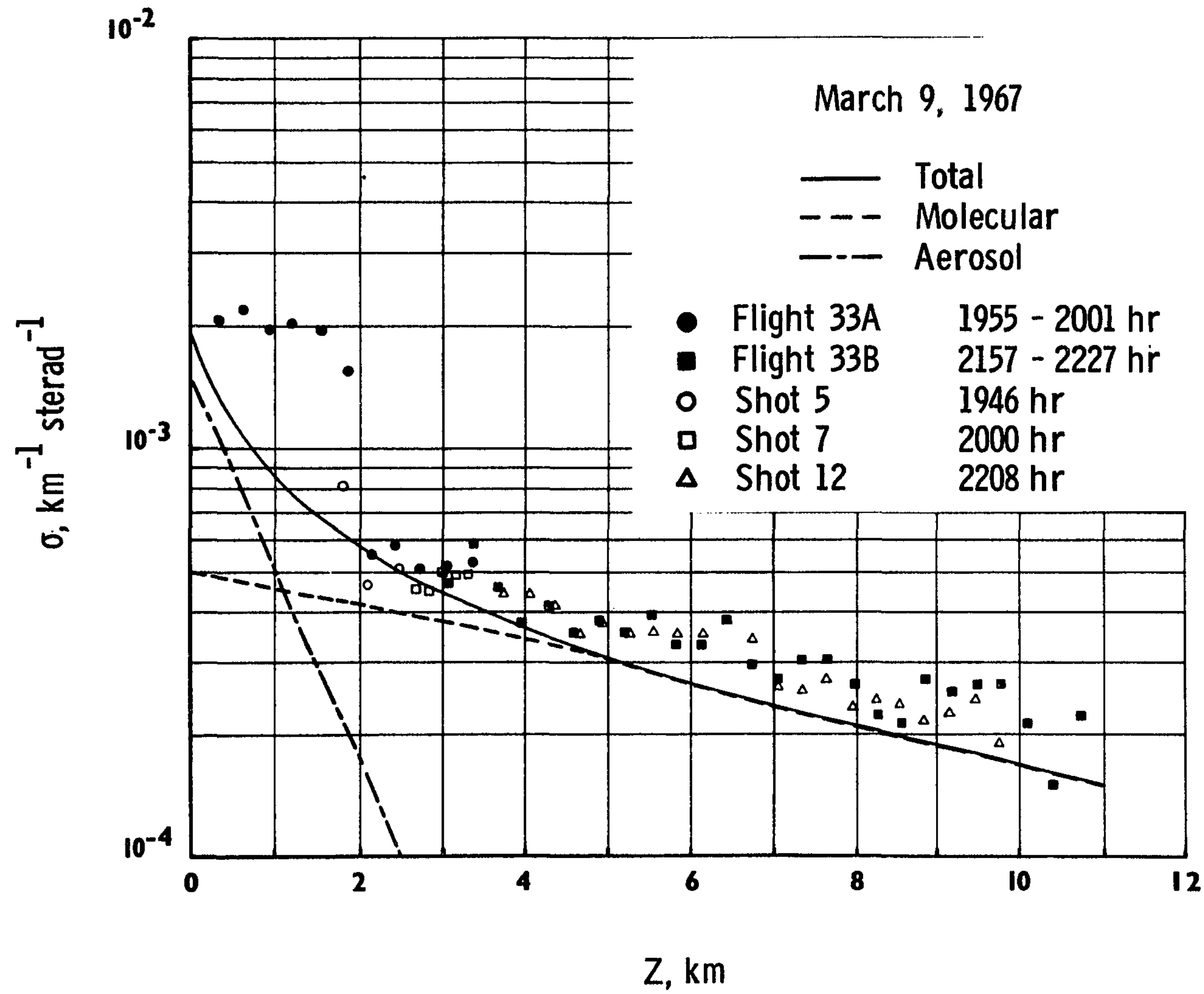

Figure 18.- Simultaneous airborne and ground-based data of the absolute cross section versus altitude. The molecular component and aerosol component is shown also.

The ground-based station compiled a total of 31 vertical profiles of the absolute cross section during the experiment. In order to investigate the presence of contamination effects, measurements were made before the arrival and after the departure of the aircraft. Each profile obtained was normalized at 7 km to the aircraft's data. Sections of three separate profiles are shown by open symbols in figure 18. Each section is taken from data recorded when the aircraft was at approximately the average altitude for the section. The absolute cross section for molecular scattering is given by the dashed curve, for aerosol scattering by the dashed-solid curve, and the total is given by the solid curve.

As can be seen in figure 18, the absolute cross section measured by each system shows a sharp decrease near 2 km corresponding to a scale height of 0.3 km. Above 2.5 km the data agree very well with that predicted for molecular scattering. The distinct increases in the cross section which are evident at 2.4, 3.4, 5.5, 6.45, and 9.45 km are believed to indicate the presence of small aerosol concentrations.

Vc. Observations of Meteorological Phenomena

Aerosol Trapping

It is, of course, well known that the temperature profile of the atmosphere reflects the aerosol number density. In a region containing a temperature inversion, cool air is capped by warm air thereby trapping aerosols in the stable region at the base of the inversion. This phenomenon has been observed in many instances, and typical examples are shown in figure 19. Since the temperature profiles are obtained from the Wallops Island radiosonde, 75 miles northeast of Williamsburg, it is questionable whether the same profile exists over Williamsburg. The

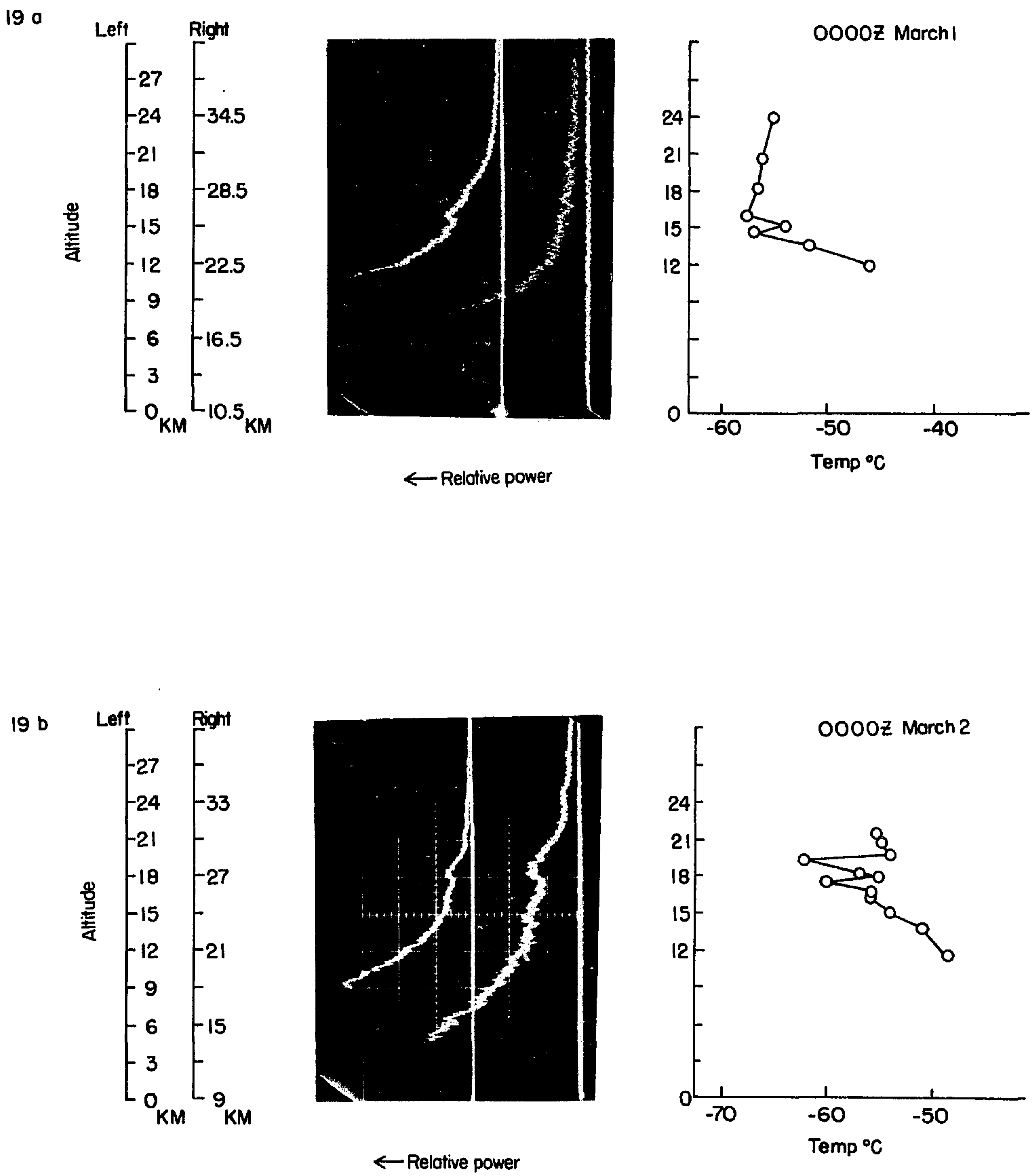

Figure 19.- Examples of aerosol trapping.

upper atmosphere profile is very likely identical; in the lower few kilometers, differences can be expected. Figure 19 shows data obtained on February 28 and March 1, 1967, and the temperature profile as measured over Wallops Island. An enhancement can be seen in figure 19(a), the February 28 profile, at 15.9 km. The height of this enhancement corresponds to the height of a 4° C temperature inversion. On March 1, figure 19(b), an 8° C inversion at 18 km corresponds to the enhancement at 18 km in the scattering profile.

Since the laser backscatter technique can detect very small aerosol concentrations, it constitutes an excellent method for observing the fine temperature structure of both the troposphere and stratosphere.

Studies of Cloud Structures

In order to demonstrate the ability of the laser backscatter technique to observe meteorological phenomena, a number of cloud systems have been observed. No systematic observations have been made nor has any attempt been made to fit polydisperse aerosol models to our measurements. The results obtained, however, clearly demonstrate that significant contributions to the physics of clouds could be made by systematic laser radar cloud observations.

The structure evident in figure 20(a) is a high cirrus cloud extending from 9 to 12 km; also evident is an altostratus cloud at 5.85 km of thickness 300 m. The return in figure 20(b) shows a cirrus cloud system centered at approximately 11.85 km. Figure 20(c) shows another cirrus cloud which at the time of observation was stratified into three layers. The base of this system was 11.7 km, while the top was 13.35 km. Figure 20(d)

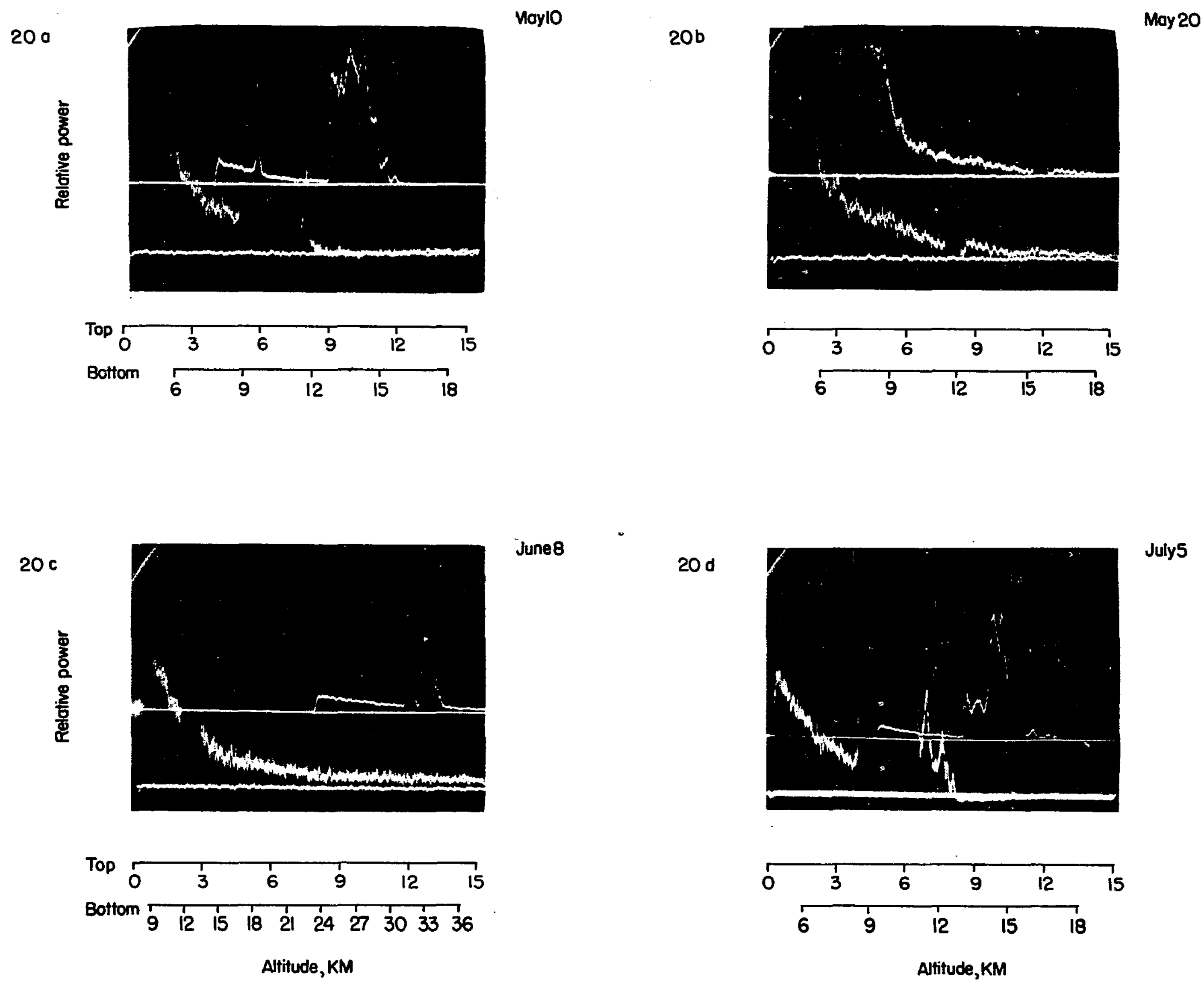

Figure 20.- Examples of cloud structure.

is an example of a dense cirrus similar to that found in figure 20(a) extending from 8.7 km to 11.25 km. The existence of this system was verified by pilot report. It should be noted, however, that laser radar can detect the formation and dissipation of clouds long before they are discernible by eye.

Two-Dimensional Mapping

An example of two-dimensional mapping of the atmospheric aerosol is shown in figure 21. The observations shown were taken 1 minute apart at various elevation angles. Figure 21(a) was recorded with the system at an elevation angle of 67.5°. The aerosol structure evident from 2.7 to 4 km was examined by repeating the experiment at the zenith as shown in figure 21(b). The time of return from the base and top of this layer has decreased as expected. The layer is horizontally stratified with the maximum return corresponding to 3.2 km. Figures 21(c) and 21(d) repeat this experiment at elevation angles of 56.25° and 90°, respectively. An analysis of the return shows that the layer remained horizontally stratified at the same height. A three-dimensional mapping could, of course, be made by rotating the system azimuthally.

Jet-Stream Studies

On the evening of May 10, 1967, an anomalous cross section was observed in the region 8.5 to 11.2 km. This height interval corresponded to a report of jet-stream activity existing over Wallops Island. Since the jet stream normally has an elliptical geometrical cross section with its major axis extending horizontally for hundreds of kilometers, it is reasonable to assume that this jet stream also existed over Williamsburg.

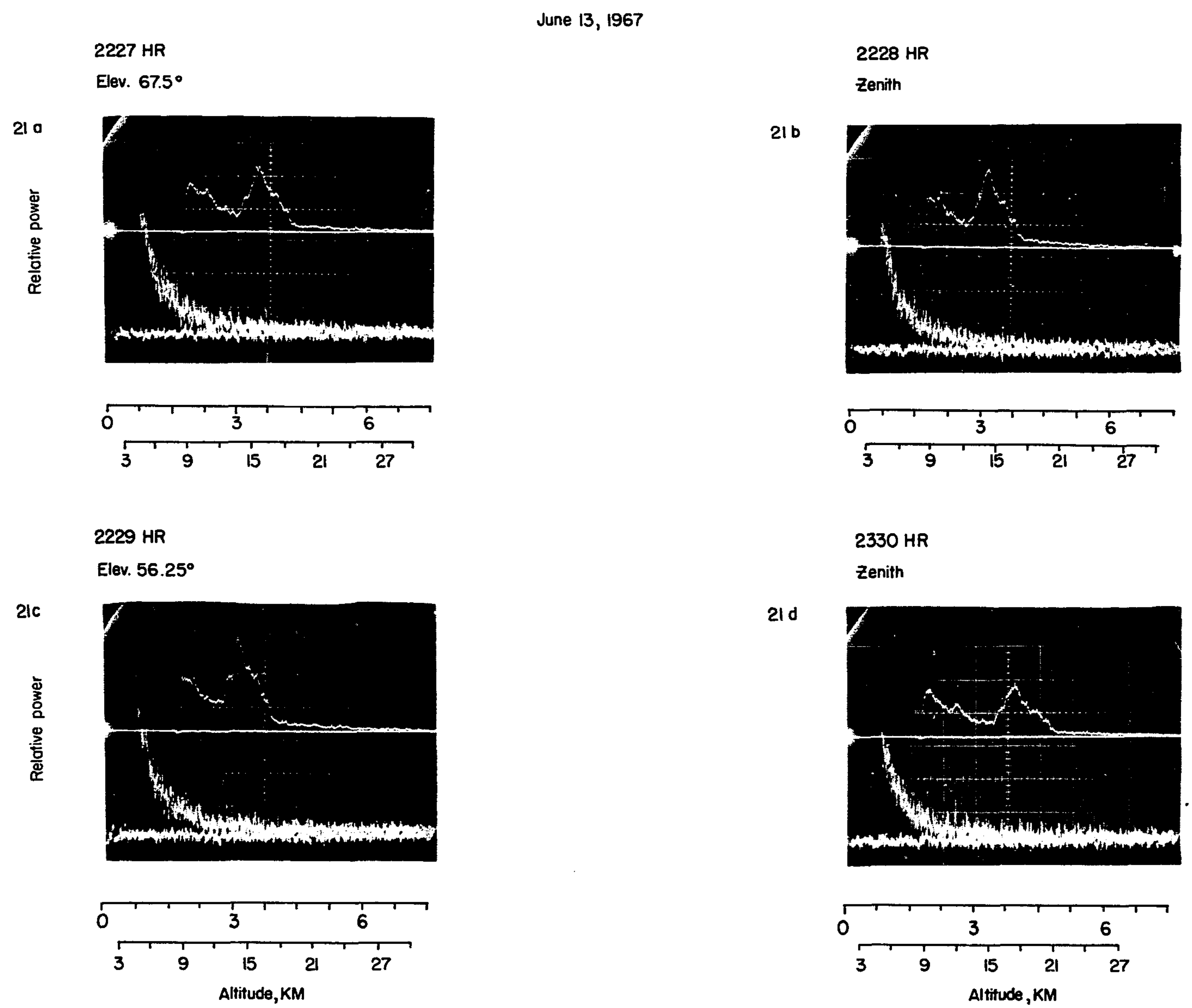

Figure 21.- Two-dimensional mapping.

Figure 22 gives the wind speed and temperature profiles that were recorded over Wallops Island. The wind direction (300°) over the height range 8.5 to 11.2 km was very nearly constant. Shown also in figure 22 is the relative backscattered power from this region; the maximum return corresponds exactly to the height of maximum winds. For the jet stream to have a large scattering cross section, large quantities of particulate matter must be trapped in the flow. Such quantities possibly could be furnished by dust storms, thunder storms, volcanic activity, forest fires, and many other phenomena. It is also well known that jet streams can transport particulate matter over very large distances. On the other hand, cirrus clouds are frequently found on the perimeter of jet streams. Either of these phenomena could account for the measurement shown in figure 22.

Studies of Atmospheric Turbulence

A series of experiments have been performed over Williamsburg in which a fully instrumented jet aircraft was directed into altitude regions which showed unusual scattering properties. This series of experiments have enabled us to correlate the scattering properties of the lower atmosphere with a number of meteorological phenomena. These experiments were performed on March 9, June 5, and July 5 with a T-33 type jet trainer whose altitude limit is 12 km. A number of similar experiments are planned for the future utilizing the T-33 jet and an Air Force F106 jet whose altitude limit is about 15 km. These aircraft are equipped to measure most of the atmospheric parameters and to collect aerosol samples; in consequence, definitive aerosol models for comparison with experiment will be available in the future.

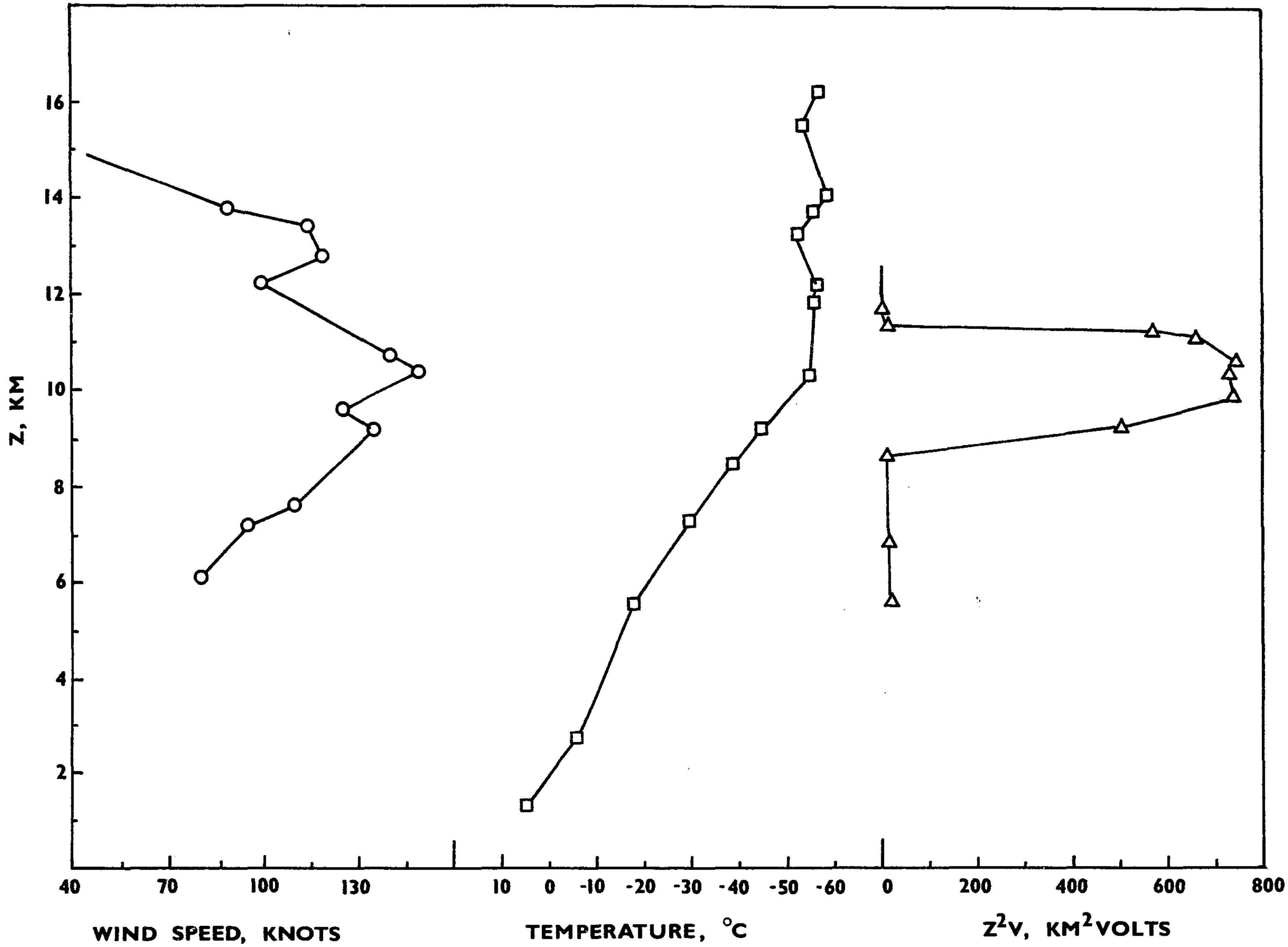

Figure 22.- Example of jet stream activity.

Correlation of the scattering properties of a region of the atmosphere with clear air turbulence has been established, but in view of the limited data obtained it cannot be considered definitive at this stage.

Figure 23 shows examples of the returns when the pilot reported light turbulence at various altitudes. These records were obtained at the time the pilot reported light turbulence. Figure 23(a) (March 9 series) shows an enhancement centered at 3.45 km (11,320 ft). The pilot reported light turbulence from 12,000 to 13,300 ft. Figure 23(b) (June 5 series) shows an enhancement centered at 2.1 km (6,890 ft). The base of the enhancement is at 1.95 km (6,400 ft). The pilot reported light turbulence in clear air at 6,500 ft. Figure 23(c) (June 5 series) shows an enhancement centered at 8.4 km (27,500 ft). This corresponds to the pilot's report of light turbulence at 27,500 ft. Figure 23(d) (July 5 series) indicates that there is a definite change in gradient from 2.55 to 2.5 km (8,360 to 8,860 ft). The pilot encountered light turbulence from 8,400 to 8,900 ft. An enhancement also appears at 2.4 km (7,870 ft); the pilot reported light turbulence at 8,000 ft. When the oscilloscope time uncertainty of 3 percent and the aircraft's altimeter error of a few hundred feet is taken into consideration, the above correlation becomes excellent.

These preliminary results seem to indicate that the scattering properties of the atmosphere can be related to the presence of clear air turbulence. The enhancements noted in figure 23 are probably regions of relatively high aerosol concentration; a mechanism for aerosol trapping in clear air turbulence, however, has not been developed.

CONCLUSIONS

This work has demonstrated the ability of laser radar to provide an accurate quantitative description of the particulate and molecular content of the atmosphere.

Rigorous Mie theory has been used to treat aerosol scattering at laser wavelengths for the first time, and these calculations provide a basis for understanding the measurements made. The aerosol scattering calculations further suggest extension of the experiment to laser wavelengths other than 6943 Å, and will provide the basis for interpreting future measurements.

In general, the experimental results show excellent agreement with aerosol number density Model I. It can, therefore, be inferred that the atmospheric aerosol concentration decreases exponentially with height to 5 km, remains relatively constant from 5 km to about 12 km, and then increases reaching a relative maximum near 18 km. The experimental results obtained are consistent with the Junge fourth power size distribution law and Rosen's direct samplings of the atmospheric aerosol.

Finally, this experiment has provided observations of various meteorological phenomena. Systematic measurements of these phenomena have not, of course, been made nor have any models been constructed to explain these observations. Nevertheless, this paper provides a general basis for the solution of the associated scattering problem and clearly demonstrates the potential value of laser radar studies of meteorological phenomena.

APPENDIX I

MIE INTENSITY FUNCTIONS FOR BACKSCATTER

The scattered intensity for vertically polarized light incident on a sphere of radius r is given as

$$I = \frac{i}{k^2 z^2} I_o$$

where

I_o = the intensity of the incident wave

i = the scattered intensity function

$k = \frac{2\pi}{\lambda}$, the free-space propagation constant

λ = the wavelength of the incident light

z = the distance from scatterer to observer.

The scattered intensity function is given as

$$i = |S|^2 = S^*S$$

where S is given from Mie theory (cf. Deirmendjian[36]) as

$$S(\alpha,\eta,\theta) = \sum_{1}^{\infty} \frac{2m+1}{m(m+1)}\left[a_m\tau_m + b_m\pi_m\right]$$

where a_m and b_m are the complex Mie scattering coefficients, η the complex index of refraction, and θ is the scattering angle measured from the forward direction. The Mie scattering coefficients are given by

$$a_m(\alpha,\eta) = \frac{\left[\frac{A_m}{\eta}+\frac{m}{\alpha}\right]J_{m+\frac{1}{2}}(\alpha) - J_{m-\frac{1}{2}}(\alpha)}{\left[\frac{A_m}{\eta}+\frac{m}{\alpha}\right]\left[J_{m+\frac{1}{2}}(\alpha)+i(-1)^m J_{-m-\frac{1}{2}}(\alpha)\right] - J_{m-\frac{1}{2}}(\alpha)+i(-1)^m J_{-m+\frac{1}{2}}(\alpha)}$$

where

$$A_m(\eta\alpha) = -\frac{m}{\eta\alpha} + \frac{J_{m-\frac{1}{2}}(\eta\alpha)}{J_{m+\frac{1}{2}}(\eta\alpha)}$$

and $b_m(\eta\alpha)$ can be found by substituting ηA_m for $\frac{A_m}{\eta}$ in the above equation. The angular dependence of the intensity function is given by

$$\pi_m\,(x) = \frac{dP_m(x)}{dx}$$

and

$$\tau_m(x) = x\pi_m - (1 - x^2)\pi_m{}'$$

where

$$x = \cos\,\theta$$

$$\pi_m{}' = \frac{d^2P_m(x)}{dx^2}$$

and

$P_m(x)$ = the Legendre polynomial of degree m

For backscatter ($\theta = 180^\circ$)

$$\pi_m = -\tau_m = (-1)^{m+1}\,\frac{m(m+1)}{2}$$

Therefore,

$$S = \sum_{1}^{\infty} (-1)^{m+1}\left(m + \frac{1}{2}\right)\left[a_m - b_m\right]$$

and

$$i = \left| \sum_{1}^{\infty} (-1)^{m+1}\left(m + \frac{1}{2}\right)\left[a_m - b_m\right] \right|^2$$

The scattering coefficients, a_m and b_m, were terminated when $|a_m|$ and $|b_m| \leq 10^{-8}$. Values of the intensity for $\alpha = 0.01\ (0.01)\ 2.0$, $2.0(0.1)\ 181.9$ and $\eta = 1.5$ are tabulated in Appendix II.

The single particle Mie cross sections are given as

$$\sigma_{\text{extinction}} = \frac{2\pi r^2}{\alpha^2} \sum_{m=1}^{\infty} (2m + 1)\mathrm{Re}(a_m + b_m)$$

$$\sigma_{\text{scattering}} = \frac{2\pi r^2}{\alpha^2} \sum_{m=1}^{\infty} (2m + 1)\left(\left|a_m\right|^2 + \left|b_m\right|^2\right)$$

and

$$\sigma_{\text{absorption}} = \sigma_{\text{extinction}} - \sigma_{\text{scattering}}$$

$\sigma_A = 0$ for a real index of refraction; therefore, $\sigma_E = \sigma_S$. The dimensionless Mie scattering coefficient (efficiency factor for scattering) is given by

$$Q_S = \frac{\sigma_S}{\pi r^2}$$

Q_S is defined as the ratio of total flux scattered by one particle in all directions to the flux incident on the geometrical cross section πr^2 of the spherical particle.

APPENDIX II

Values of i (180°) and Q_S for α = 0.01 (0.01) 2.0 and 2.0 (0.1) 181.9 are tabulated in this appendix. The notation $\alpha = 0.01(0.01)2.0$ is to be interpreted as: $\alpha_1 = 0.01$, $\alpha_2 = 2.0$, and $\Delta\alpha = 0.01$; the notation 8.6501713D-14 means $8.6501713 \times 10^{-14}$. I(180) is the intensity function for a scattering angle of 180°. QS is Q_S, the efficiency factor for scattering.

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
0.01	2	2.3068213D-09	8.6501713D-14
0.02	2	3.6909919D-08	5.5354421D-12
0.03	2	1.8686306D-07	6.3039485D-11
0.04	2	5.9060862D-07	3.5409751D-10
0.05	2	1.4420066D-06	1.3502859D-09
0.06	2	2.9903750D-06	4.0301478D-09
0.07	3	5.5405408D-06	1.0157209D-08
0.08	3	9.4529010D-06	2.2618483D-08
0.09	3	1.5143497D-05	4.5822705D-08
0.10	3	2.3084092D-05	8.6157356D-08
0.11	3	3.3802263D-05	1.5250344D-07
0.12	3	4.7881493D-05	2.5680676D-07
0.13	3	6.5961286D-05	4.1470445D-07
0.14	3	8.8737262D-05	6.4620509D-07
0.15	3	1.1696128D-04	9.7642089D-07
0.16	3	1.5144155D-04	1.4363502D-06
0.17	3	1.9304276D-04	2.0637081D-06
0.18	3	2.4268618D-04	2.9038033D-06
0.19	3	3.0134979D-04	4.0104589D-06
0.20	3	3.7006836D-04	5.4469738D-06
0.21	3	4.4993366D-04	7.2871260D-06
0.22	3	5.4209442D-04	9.6162070D-06
0.23	4	6.4775652D-04	1.2532093D-05
0.24	4	7.6818289D-04	1.6146344D-05
0.25	4	9.0469397D-04	2.0585336D-05
0.26	4	1.0586671D-03	2.5991400D-05
0.27	4	1.2315375D-03	3.2524005D-05
0.28	4	1.4247969D-03	4.0360929D-05
0.29	4	1.6399950D-03	4.9699472D-05
0.30	4	1.8787383D-03	6.0757637D-05
0.31	4	2.1426904D-03	7.3775359D-05
0.32	4	2.4335719D-03	8.9015692D-05
0.33	4	2.7531602D-03	1.0676602D-04
0.34	4	3.1032890D-03	1.2733922D-04
0.35	4	3.4858483D-03	1.5107485D-04
0.36	4	3.9027839D-03	1.7834028D-04
0.37	4	4.3560970D-03	2.0953180D-04
0.38	4	4.8478431D-03	2.4507567D-04
0.39	4	5.3801335D-03	2.8542927D-04
0.40	4	5.9551313D-03	3.3108188D-04
0.41	4	6.5750544D-03	3.8255584D-04
0.42	4	7.2421705D-03	4.4040714D-04
0.43	4	7.9588006D-03	5.0522652D-04
0.44	4	8.7273139D-03	5.7763988D-04
0.45	4	9.5501289D-03	6.5830905D-04
0.46	4	1.0429713D-02	7.4793242D-04
0.47	4	1.1368576D-02	8.4724496D-04
0.48	4	1.2369277D-02	9.5701907D-04
0.49	4	1.3434415D-02	1.0780642D-03
0.50	4	1.4566628D-02	1.2112274D-03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
0.51	5	1.5768596D-02	1.3573925D-03
0.52	5	1.7043033D-02	1.5174807D-03
0.53	5	1.8392690D-02	1.6924495D-03
0.54	5	1.9820346D-02	1.8832923D-03
0.55	5	2.1328809D-02	2.0910375D-03
0.56	5	2.2920915D-02	2.3167475D-03
0.57	5	2.4599520D-02	2.5615177D-03
0.58	5	2.6367500D-02	2.8264748D-03
0.59	5	2.8227745D-02	3.1127748D-03
0.60	5	3.0183155D-02	3.4216017D-03
0.61	5	3.2236641D-02	3.7541648D-03
0.62	5	3.4391113D-02	4.1116967D-03
0.63	5	3.6649481D-02	4.4954498D-03
0.64	5	3.9014647D-02	4.9066939D-03
0.65	5	4.1489500D-02	5.3467125D-03
0.66	5	4.4076915D-02	5.8167991D-03
0.67	5	4.6779740D-02	6.3182534D-03
0.68	5	4.9600797D-02	6.8523766D-03
0.69	5	5.2542870D-02	7.4204671D-03
0.70	5	5.5608706D-02	8.0238157D-03
0.71	5	5.8801000D-02	8.6636987D-03
0.72	5	6.2122396D-02	9.3413743D-03
0.73	5	6.5575473D-02	1.0058075D-02
0.74	5	6.9162744D-02	1.0815002D-02
0.75	5	7.2886644D-02	1.1613316D-02
0.76	5	7.6749529D-02	1.2454136D-02
0.77	5	8.0753658D-02	1.3338523D-02
0.78	5	8.4901200D-02	1.4267481D-02
0.79	5	8.9194209D-02	1.5241943D-02
0.80	5	9.3634632D-02	1.6262763D-02
0.81	5	9.8224290D-02	1.7330711D-02
0.82	5	1.0296488D-01	1.8446459D-02
0.83	5	1.0785797D-01	1.9610578D-02
0.84	5	1.1290497D-01	2.0823523D-02
0.85	5	1.1810714D-01	2.2085619D-02
0.86	5	1.2346561D-01	2.3397068D-02
0.87	5	1.2898130D-01	2.4757919D-02
0.88	6	1.3465502D-01	2.6168076D-02
0.89	6	1.4048734D-01	2.7627269D-02
0.90	6	1.4647871D-01	2.9135064D-02
0.91	6	1.5262935D-01	3.0690837D-02
0.92	6	1.5893932D-01	3.2293773D-02
0.93	6	1.6540849D-01	3.3942859D-02
0.94	6	1.7203650D-01	3.5636859D-02
0.95	6	1.7882284D-01	3.7374330D-02
0.96	6	1.8576680D-01	3.9153592D-02
0.97	6	1.9286747D-01	4.0972735D-02
0.98	6	2.0012370D-01	4.2829589D-02
0.99	6	2.0753424D-01	4.4721759D-02
1.00	6	2.1509759D-01	4.6646578D-02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
1.01	6	2.2281207D-01	4.8601112D-02
1.02	6	2.3067588D-01	5.0582188D-02
1.03	6	2.3868698D-01	5.2586336D-02
1.04	6	2.4684325D-01	5.4609840D-02
1.05	6	2.5514238D-01	5.6648710D-02
1.06	6	2.6358195D-01	5.8698681D-02
1.07	6	2.7215939D-01	6.0755224D-02
1.08	6	2.8087208D-01	6.2813562D-02
1.09	6	2.8971726D-01	6.4868638D-02
1.10	6	2.9869216D-01	6.6915169D-02
1.11	6	3.0779392D-01	6.8947615D-02
1.12	6	3.1701970D-01	7.0960226D-02
1.13	6	3.2636662D-01	7.2947014D-02
1.14	6	3.3583182D-01	7.4901798D-02
1.15	6	3.4541255D-01	7.6818218D-02
1.16	6	3.5510611D-01	7.8689741D-02
1.17	6	3.6490987D-01	8.0509683D-02
1.18	6	3.7482136D-01	8.2271233D-02
1.19	6	3.8483832D-01	8.3967498D-02
1.20	6	3.9495866D-01	8.5591503D-02
1.21	6	4.0518049D-01	8.7136218D-02
1.22	6	4.1550220D-01	8.8594608D-02
1.23	6	4.2592253D-01	8.9959668D-02
1.24	6	4.3644045D-01	9.1224422D-02
1.25	6	4.4705542D-01	9.2382034D-02
1.26	6	4.5776719D-01	9.3425744D-02
1.27	6	4.6857595D-01	9.4348994D-02
1.28	6	4.7948242D-01	9.5145449D-02
1.29	6	4.9048773D-01	9.5809017D-02
1.30	6	5.0159356D-01	9.6333903D-02
1.31	6	5.1280219D-01	9.6714719D-02
1.32	7	5.2411636D-01	9.6946421D-02
1.33	7	5.3553950D-01	9.7024482D-02
1.34	7	5.4707561D-01	9.6944832D-02
1.35	7	5.5872937D-01	9.6704009D-02
1.36	7	5.7050602D-01	9.6299151D-02
1.37	7	5.8241159D-01	9.5728065D-02
1.38	7	5.9445271D-01	9.4989353D-02
1.39	7	6.0663665D-01	9.4082339D-02
1.40	7	6.1897141D-01	9.3007235D-02
1.41	7	6.3146563D-01	9.1765179D-02
1.42	7	6.4412865D-01	9.0358255D-02
1.43	7	6.5697033D-01	8.8789597D-02
1.44	7	6.7000127D-01	8.7063418D-02
1.45	7	6.8323255D-01	8.5185090D-02
1.46	7	6.9667582D-01	8.3161165D-02
1.47	7	7.1034325D-01	8.0999476D-02
1.48	7	7.2424739D-01	7.8709133D-02
1.49	7	7.3840115D-01	7.6300600D-02
1.50	7	7.5281777D-01	7.3785750D-02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
1.51	7	7.6751064D-01	7.1177868D-02
1.52	7	7.8249333D-01	6.8491695D-02
1.53	7	7.9777931D-01	6.5743446D-02
1.54	7	8.1338202D-01	6.2950860D-02
1.55	7	8.2931458D-01	6.0133149D-02
1.56	7	8.4558978D-01	5.7311016D-02
1.57	7	8.6221983D-01	5.4506656D-02
1.58	7	8.7921628D-01	5.1743703D-02
1.59	7	8.9658980D-01	4.9047201D-02
1.60	7	9.1435005D-01	4.6443493D-02
1.61	7	9.3250542D-01	4.3960236D-02
1.62	7	9.5106297D-01	4.1626217D-02
1.63	7	9.7002809D-01	3.9471271D-02
1.64	7	9.8940440D-01	3.7526137D-02
1.65	7	1.0091936D 00	3.5822328D-02
1.66	7	1.0293951D 00	3.4391914D-02
1.67	7	1.0500063D 00	3.3267349D-02
1.68	7	1.0710216D 00	3.2481234D-02
1.69	7	1.0924330D 00	3.2066108D-02
1.70	7	1.1142300D 00	3.2054158D-02
1.71	7	1.1363987D 00	3.2476962D-02
1.72	7	1.1589226D 00	3.3365217D-02
1.73	7	1.1817820D 00	3.4748437D-02
1.74	7	1.2049544D 00	3.6654634D-02
1.75	7	1.2284139D 00	3.9110049D-02
1.76	7	1.2521322D 00	4.2138822D-02
1.77	7	1.2760778D 00	4.5762740D-02
1.78	7	1.3002167D 00	5.0000912D-02
1.79	7	1.3245124D 00	5.4869533D-02
1.80	7	1.3489260D 00	6.0381657D-02
1.81	7	1.3734171D 00	6.6547014D-02
1.82	8	1.3979434D 00	7.3371742D-02
1.83	8	1.4224614D 00	8.0858404D-02
1.84	8	1.4469268D 00	8.9005787D-02
1.85	8	1.4712949D 00	9.7808850D-02
1.86	8	1.4955210D 00	1.0725882D-01
1.87	8	1.5195607D 00	1.1734318D-01
1.88	8	1.5433710D 00	1.2804577D-01
1.89	8	1.5669096D 00	1.3934691D-01
1.90	8	1.5901366D 00	1.5122367D-01
1.91	8	1.6130138D 00	1.6364993D-01
1.92	8	1.6355060D 00	1.7659684D-01
1.93	8	1.6575807D 00	1.9003290D-01
1.94	8	1.6792086D 00	2.0392447D-01
1.95	8	1.7003639D 00	2.1823588D-01
1.96	8	1.7210247D 00	2.3292990D-01
1.97	8	1.7411728D 00	2.4796806D-01
1.98	8	1.7607938D 00	2.6331090D-01
1.99	8	1.7798777D 00	2.7891835D-01

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
2.00	8	1.7984181D 00	2.9474993D-01
2.10	8	1.9552558D 00	4.5670752D-01
2.20	8	2.0753330D 00	6.0066344D-01
2.30	8	2.1916077D 00	6.9661882D-01
2.40	9	2.3383119D 00	7.1720050D-01
2.50	9	2.5395196D 00	6.4653165D-01
2.60	9	2.7923933D 00	5.1468399D-01
2.70	9	3.0511927D 00	4.2340075D-01
2.80	9	3.2509890D 00	4.9196896D-01
2.90	9	3.3648126D 00	7.6350889D-01
3.00	10	3.4180561D 00	1.2024008D 00
3.10	10	3.4581109D 00	1.7489185D 00
3.20	10	3.5317452D 00	2.3268428D 00
3.30	10	3.6732589D 00	2.7926818D 00
3.40	10	3.8787859D 00	2.9123061D 00
3.50	10	4.0785497D 00	2.5534424D 00
3.60	11	4.1848669D 00	1.9710987D 00
3.70	11	4.1841505D 00	1.6145086D 00
3.80	11	4.1263581D 00	1.7487198D 00
3.90	11	4.0670945D 00	2.4757476D 00
4.00	11	4.0524522D 00	3.8763294D 00
4.10	11	4.1186715D 00	5.9065162D 00
4.20	12	4.2554673D 00	7.9164071D 00
4.30	12	4.3592588D 00	8.5783081D 00
4.40	12	4.3325897D 00	7.5030895D 00
4.50	12	4.2025047D 00	5.8236772D 00
4.60	12	4.0412566D 00	4.6135171D 00
4.70	12	3.8996726D 00	4.3852420D 00
4.80	12	3.8190551D 00	5.5818766D 00
4.90	13	3.8380697D 00	8.8263207D 00
5.00	13	3.9278267D 00	1.3774257D 01
5.10	13	3.9325254D 00	1.7297876D 01
5.20	13	3.7831887D 00	1.7205958D 01
5.30	13	3.5683206D 00	1.5128197D 01
5.40	13	3.3567136D 00	1.3078475D 01
5.50	13	3.1815510D 00	1.2142479D 01
5.60	14	3.0835001D 00	1.3090935D 01
5.70	14	3.1101315D 00	1.6762585D 01
5.80	14	3.1904932D 00	2.2258471D 01
5.90	14	3.1116533D 00	2.5349432D 01
6.00	14	2.9038944D 00	2.5118507D 01
6.10	14	2.6852118D 00	2.3848811D 01
6.20	14	2.4861391D 00	2.3457084D 01
6.30	15	2.3299970D 00	2.5613632D 01
6.40	15	2.2713444D 00	3.2132217D 01
6.50	15	2.3672912D 00	4.2704932D 01
6.60	15	2.4479576D 00	4.5817359D 01
6.70	15	2.3144908D 00	3.7075928D 01
6.80	15	2.1461510D 00	2.9067262D 01
6.90	15	1.9949470D 00	2.5120176D 01

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
7.00	16	1.8482740D 00	2.5691367D 01
7.10	16	1.7455593D 00	3.3489306D 01
7.20	16	1.7719754D 00	5.5090783D 01
7.30	16	1.9721784D 00	9.0141332D 01
7.40	16	2.0009740D 00	9.0661178D 01
7.50	16	1.8848487D 00	6.2508318D 01
7.60	16	1.8318063D 00	3.8983669D 01
7.70	17	1.7641557D 00	2.5278840D 01
7.80	17	1.6723328D 00	2.2521618D 01
7.90	17	1.6366741D 00	3.3505333D 01
8.00	17	1.7777188D 00	7.4093853D 01
8.10	17	2.0282704D 00	1.3780715D 02
8.20	17	1.9518844D 00	1.2766250D 02
8.30	17	1.9488144D 00	9.4845909D 01
8.40	17	2.0126781D 00	5.9092575D 01
8.50	18	1.9849031D 00	3.4657789D 01
8.60	18	1.9262683D 00	3.1306861D 01
8.70	18	1.9568639D 00	5.0745067D 01
8.80	18	2.2263834D 00	1.1866609D 02
8.90	18	2.3239969D 00	1.5205035D 02
9.00	18	2.2384247D 00	1.2599866D 02
9.10	18	2.3708447D 00	1.0734810D 02
9.20	19	2.4752694D 00	6.6746659D 01
9.30	19	2.4230707D 00	4.2394480D 01
9.40	19	2.3816682D 00	5.3508158D 01
9.50	19	2.4791278D 00	1.1102510D 02
9.60	19	2.7985173D 00	2.1456064D 02
9.70	19	2.6198254D 00	1.3431642D 02
9.80	19	2.6454223D 00	1.0977280D 02
9.90	19	2.8566738D 00	9.0659301D 01
10.00	20	2.8819989D 00	4.2376591D 01
10.10	20	2.7829316D 00	3.2191590D 01
10.20	20	2.7574945D 00	6.7552655D 01
10.30	20	2.9621212D 00	2.1880930D 02
10.40	20	2.9679505D 00	2.2397409D 02
10.50	20	2.8014075D 00	1.3921511D 02
10.60	20	2.9158530D 00	1.2594857D 02
10.70	21	3.1115544D 00	6.1581017D 01
10.80	21	2.9811551D 00	1.3248551D 01
10.90	21	2.8731979D 00	2.3505196D 01
11.00	21	2.8763188D 00	8.6074999D 01
11.10	21	3.1492756D 00	3.0866753D 02
11.20	21	2.7988209D 00	1.5023295D 02
11.30	21	2.7509108D 00	1.5738020D 02
11.40	21	2.9338295D 00	1.6400937D 02
11.50	22	2.9538099D 00	3.0394429D 01
11.60	22	2.7596589D 00	2.1231571D 01
11.70	22	2.6751410D 00	5.4247463D 01
11.80	22	2.8112403D 00	2.1885920D 02
11.90	22	2.6359504D 00	1.1579257D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
12.00	22	2.4760009D 00	9.1012869D 01
12.10	22	2.4948784D 00	1.5285388D 02
12.20	22	2.7365391D 00	1.3794737D 02
12.30	23	2.5065602D 00	1.6209956D 01
12.40	23	2.3791158D 00	4.6962349D 01
12.50	23	2.3395366D 00	1.3390634D 02
12.60	23	2.4581580D 00	2.0988003D 02
12.70	23	2.1643385D 00	5.6320928D 01
12.80	23	2.1101086D 00	7.6212953D 01
12.90	23	2.2405492D 00	1.4699107D 02
13.00	23	2.2814358D 00	2.2667992D 01
13.10	24	2.1088072D 00	1.2540805D 01
13.20	24	2.0463399D 00	5.2925241D 01
13.30	24	2.2767882D 00	4.1163795D 02
13.40	24	1.9358992D 00	6.5575672D 01
13.50	24	1.8687799D 00	7.5012136D 01
13.60	24	1.8887408D 00	1.1595664D 02
13.70	24	2.2079051D 00	9.4856101D 01
13.80	24	1.9725161D 00	3.5482530D 00
13.90	25	1.9410720D 00	1.7089495D 01
14.00	25	1.9518203D 00	9.0498637D 01
14.10	25	1.9021673D 00	5.3989727D 01
14.20	25	1.8284735D 00	3.9677487D 01
14.30	25	1.8279764D 00	8.0492169D 01
14.40	25	1.9817065D 00	1.9290867D 02
14.50	25	2.0205273D 00	1.0217179D 00
14.60	25	2.0204369D 00	2.5973988D 01
14.70	26	2.0363601D 00	4.7890621D 01
14.80	26	2.1235028D 00	8.0104341D 01
14.90	26	1.9896645D 00	4.8137920D 00
15.00	26	1.9847069D 00	1.6358530D 01
15.10	26	2.0341823D 00	6.8982463D 01
15.20	26	2.2959995D 00	7.1771130D 01
15.30	26	2.2136654D 00	1.4017561D 01
15.40	26	2.2763841D 00	3.0028227D 01
15.50	27	2.5288381D 00	3.9587128D 02
15.60	27	2.2678750D 00	4.2658138D 00
15.70	27	2.2543691D 00	9.6622777D 00
15.80	27	2.2674520D 00	1.7343173D 01
15.90	27	2.4849892D 00	1.6335757D 02
16.00	27	2.4199333D 00	7.6351396D-01
16.10	27	2.5164128D 00	8.4364698D 00
16.20	27	2.5645931D 00	3.2300731D 01
16.30	28	2.5316853D 00	1.5790700D 01
16.40	28	2.5025660D 00	5.5238316D 00
16.50	28	2.4883802D 00	1.4962029D 01
16.60	28	2.5121490D 00	4.7881423D 01
16.70	28	2.5584385D 00	1.8240927D 01
16.80	28	2.6349772D 00	3.8784183D 00
16.90	28	2.6973474D 00	2.7255821D 00

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
17.00	28	2.6761554D 00	5.6487674D 01
17.10	29	2.6221363D 00	1.6150537D 01
17.20	29	2.5810703D 00	4.8386316D 00
17.30	29	2.5536168D 00	1.6740802D 01
17.40	29	2.6127521D 00	4.5894866D 01
17.50	29	2.5835174D 00	1.6087003D 01
17.60	29	2.6651561D 00	1.9705471D 01
17.70	29	2.6701940D 00	1.0411958D 02
17.80	29	2.5812029D 00	3.3708406D 01
17.90	30	2.5163565D 00	2.4157580D 01
18.00	30	2.4603097D 00	9.6002179D 00
18.10	30	2.5649815D 00	2.9660774D 02
18.20	30	2.4032198D 00	1.8652894D 00
18.30	30	2.4588493D 00	5.1201138D 01
18.40	30	2.7142825D 00	7.2970980D 02
18.50	30	2.4217637D 00	6.3079326D 01
18.60	30	2.3470784D 00	2.9923287D 01
18.70	31	2.2767283D 00	1.6832877D 01
18.80	31	2.2246740D 00	7.4800713D 00
18.90	31	2.1770596D 00	1.5070942D 01
19.00	31	2.1818503D 00	8.3167344D 00
19.10	31	2.2687271D 00	1.2339735D 02
19.20	31	2.2298781D 00	2.2558695D 02
19.30	31	2.1602628D 00	1.4181312D 02
19.40	31	2.1025554D 00	5.6427725D 01
19.50	32	2.0409124D 00	1.3610624D 01
19.60	32	1.9971263D 00	1.4143375D 01
19.70	32	1.9757085D 00	3.9511742D-01
19.80	32	2.0333365D 00	4.4426881D 01
19.90	32	2.1017683D 00	2.4419215D 02
20.00	32	2.0358369D 00	2.9961588D 02
20.10	32	2.0126850D 00	2.3375780D 02
20.20	32	1.9769231D 00	1.1596860D 02
20.30	32	1.9414721D 00	5.1086407D 01
20.40	33	1.9166621D 00	7.7784032D 00
20.50	33	1.9352735D 00	3.9435196D 01
20.60	33	2.0574330D 00	2.0708999D 02
20.70	33	2.0418474D 00	3.1472691D 02
20.80	33	2.0240858D 00	2.9989008D 02
20.90	33	2.0443000D 00	2.4928961D 02
21.00	33	2.0822506D 00	5.0042140D 02
21.10	33	2.0076423D 00	5.9572139D 01
21.20	34	2.0153951D 00	3.1724391D 01
21.30	34	2.0826497D 00	1.3505771D 02
21.40	34	2.1960166D 00	5.6071277D 02
21.50	34	2.1321410D 00	4.1517651D 02
21.60	34	2.1817171D 00	3.1664790D 02
21.70	34	2.2126234D 00	2.1105837D 02
21.80	34	2.1919999D 00	8.3135346D 01
21.90	34	2.1985925D 00	3.7421869D 01

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
22.00	35	2.2240742D 00	3.4624398D 01
22.10	35	2.3546212D 00	3.8928805D 02
22.20	35	2.3215699D 00	7.1075441D 02
22.30	35	2.3128969D 00	5.8799871D 02
22.40	35	2.3960827D 00	4.5489571D 02
22.50	35	2.3860640D 00	1.2788657D 02
22.60	35	2.3771025D 00	3.3418704D 01
22.70	35	2.3897706D 00	2.5035190D 01
22.80	35	2.4268306D 00	6.8105567D 01
22.90	36	2.5320294D 00	7.1872949D 02
23.00	36	2.4168632D 00	6.0788963D 02
23.10	36	2.4622583D 00	7.4105920D 02
23.20	36	2.5184919D 00	4.8540986D 02
23.30	36	2.4711458D 00	1.4733278D 02
23.40	36	2.4697959D 00	9.4460036D 01
23.50	36	2.4659221D 00	6.0489961D 01
23.60	36	2.5596554D 00	5.0021665D 02
23.70	37	2.4630979D 00	5.5324700D 02
23.80	37	2.4165451D 00	4.8993211D 02
23.90	37	2.4974293D 00	7.0769992D 02
24.00	37	2.4648648D 00	3.4509011D 02
24.10	37	2.4223929D 00	1.5485012D 02
24.20	37	2.4111128D 00	1.2589484D 02
24.30	37	2.4045965D 00	1.6681253D 02
24.40	37	2.4586459D 00	1.1042652D 03
24.50	37	2.3079463D 00	5.0929157D 02
24.60	38	2.3075414D 00	5.5436616D 02
24.70	38	2.3880626D 00	5.6456637D 02
24.80	38	2.2908080D 00	1.2793948D 02
24.90	38	2.2730355D 00	1.0995016D 02
25.00	38	2.2497516D 00	9.7565356D 01
25.10	38	2.3195856D 00	6.4129925D 02
25.20	38	2.1704399D 00	7.1510751D 02
25.30	38	2.1160770D 00	5.7896734D 02
25.40	39	2.1757743D 00	9.7986887D 02
25.50	39	2.1594692D 00	2.6307048D 02
25.60	39	2.1148642D 00	1.0422714D 02
25.70	39	2.1103347D 00	9.8209027D 01
25.80	39	2.0911060D 00	8.4224329D 01
25.90	39	2.0897804D 00	8.5839038D 02
26.00	39	1.9860693D 00	4.1076077D 02
26.10	39	1.9791982D 00	6.5722298D 02
26.20	39	2.1093627D 00	1.1643440D 03
26.30	40	2.0086668D 00	2.1514104D 02
26.40	40	2.0299230D 00	2.6356543D 02
26.50	40	2.0270235D 00	1.8736776D 02
26.60	40	2.1395103D 00	1.1766815D 03
26.70	40	1.9591885D 00	3.1008075D 02
26.80	40	1.9346953D 00	3.0183225D 02
26.90	40	1.9910092D 00	8.0957068D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
27.00	40	2.0200887D 00	3.2909987D 02
27.10	41	2.0283713D 00	2.6796376D 02
27.20	41	2.0713252D 00	3.7816285D 02
27.30	41	2.0769970D 00	2.7238391D 02
27.40	41	2.0550421D 00	9.5838437D 02
27.50	41	2.0140175D 00	3.5752004D 02
27.60	41	2.0233736D 00	4.5174189D 02
27.70	41	2.1914564D 00	1.0423828D 03
27.80	41	2.1022469D 00	1.0113998D 02
27.90	41	2.1757294D 00	2.8992272D 02
28.00	42	2.2047918D 00	2.9300442D 02
28.10	42	2.2893073D 00	1.8024423D 03
28.20	42	2.1676808D 00	4.6998206D 02
28.30	42	2.1602743D 00	4.5115228D 02
28.40	42	2.2066582D 00	9.7440774D 02
28.50	42	2.2341978D 00	1.3080595D 02
28.60	42	2.2799449D 00	3.2351660D 02
28.70	42	2.3475487D 00	3.8569734D 02
28.80	43	2.3687470D 00	2.2539185D 02
28.90	43	2.3232692D 00	3.9775079D 02
29.00	43	2.2992901D 00	2.7857540D 02
29.10	43	2.2995169D 00	4.3848128D 02
29.20	43	2.4393734D 00	1.2002337D 03
29.30	43	2.3459240D 00	3.1616747D 02
29.40	43	2.4208590D 00	7.3103540D 02
29.50	43	2.4389917D 00	5.2928550D 02
29.60	43	2.4176978D 00	6.6141415D 02
29.70	44	2.3738031D 00	2.1045328D 02
29.80	44	2.3480683D 00	1.9079279D 02
29.90	44	2.3663346D 00	6.6274298D 02
30.00	44	2.3527567D 00	9.7042427D 01
30.10	44	2.3853310D 00	4.8134437D 02
30.20	44	2.4362552D 00	9.2703682D 02
30.30	44	2.5435974D 00	3.2562264D 03
30.40	44	2.3574465D 00	4.6045835D 02
30.50	45	2.3124137D 00	2.7089260D 02
30.60	45	2.2857210D 00	3.6912558D 02
30.70	45	2.3072856D 00	8.5464620D 01
30.80	45	2.2742038D 00	2.2141595D 02
30.90	45	2.3280059D 00	7.0473587D 02
31.00	45	2.3204026D 00	6.6682217D 02
31.10	45	2.2668165D 00	7.1004665D 02
31.20	45	2.2180777D 00	3.4466541D 02
31.30	45	2.1712389D 00	3.2982319D 02
31.40	46	2.1928290D 00	1.3420414D 03
31.50	46	2.1382953D 00	2.5705083D 02
31.60	46	2.1552563D 00	6.8426691D 02
31.70	46	2.2047115D 00	1.0583146D 03
31.80	46	2.1504942D 00	8.5128583D 02
31.90	46	2.1141818D 00	3.2095286D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
32.00	46	2.0670671D 00	1.4840836D 02
32.10	46	2.0350818D 00	3.1189897D 02
32.20	47	2.0269591D 00	1.2924745D 02
32.30	47	2.0243996D 00	4.5625807D 02
32.40	47	2.0815736D 00	1.3863375D 03
32.50	47	2.1242176D 00	3.2693324D 03
32.60	47	2.0402891D 00	5.8370828D 02
32.70	47	2.0238712D 00	1.3564860D 02
32.80	47	1.9867122D 00	8.8448330D 01
32.90	47	2.0138867D 00	1.3727056D 02
33.00	47	1.9848456D 00	1.5062823D 02
33.10	48	2.0089054D 00	5.6453733D 02
33.20	48	2.0865656D 00	1.7379461D 03
33.30	48	2.0316565D 00	1.2225815D 03
33.40	48	2.0470747D 00	5.4226775D 02
33.50	48	2.0341799D 00	1.2445748D 02
33.60	48	2.0237399D 00	4.0638676D 02
33.70	48	2.0345445D 00	1.7003674D 02
33.80	48	2.0532733D 00	3.1002908D 02
33.90	48	2.1190398D 00	1.0887301D 03
34.00	49	2.1197597D 00	1.3088577D 03
34.10	49	2.1088169D 00	8.5240225D 02
34.20	49	2.1473766D 00	3.6075199D 02
34.30	49	2.1281509D 00	1.3249319D 02
34.40	49	2.1390151D 00	1.5660095D 02
34.50	49	2.1654643D 00	3.6171456D 02
34.60	49	2.1908723D 00	7.4481668D 02
34.70	49	2.2800638D 00	1.8357460D 03
34.80	50	2.2056644D 00	7.1669096D 02
34.90	50	2.2454001D 00	4.9718394D 02
35.00	50	2.2626655D 00	9.1897573D 01
35.10	50	2.2521109D 00	1.0193975D 01
35.20	50	2.2723284D 00	1.6769930D 02
35.30	50	2.2918827D 00	3.5699434D 02
35.40	50	2.3441595D 00	1.9624544D 03
35.50	50	2.3186624D 00	1.2901978D 03
35.60	50	2.2907571D 00	6.6465511D 02
35.70	51	2.3508349D 00	2.6767959D 02
35.80	51	2.3207656D 00	1.5923545D 01
35.90	51	2.3187864D 00	6.7977295D 01
36.00	51	2.3409019D 00	1.1225319D 02
36.10	51	2.3442268D 00	3.3583804D 02
36.20	51	2.4146511D 00	2.0436404D 03
36.30	51	2.2992201D 00	7.9948194D 02
36.40	51	2.3125152D 00	7.9260623D 02
36.50	52	2.3416356D 00	1.0187163D 02
36.60	52	2.2912559D 00	9.4797136D 01
36.70	52	2.3051260D 00	2.0117867D 02
36.80	52	2.3067032D 00	2.0170751D 02
36.90	52	2.3193442D 00	7.9087945D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
37.00	52	2.2658626D 00	6.0450442D 02
37.10	52	2.2163123D 00	4.6263202D 02
37.20	52	2.2675715D 00	8.0657521D 02
37.30	52	2.2209281D 00	3.3265553D 01
37.40	53	2.2024093D 00	1.3515215D 02
37.50	53	2.2156106D 00	2.2485520D 02
37.60	53	2.1978972D 00	3.0511464D 02
37.70	53	2.2429854D 00	1.5234004D 03
37.80	53	2.1137167D 00	1.8098066D 02
37.90	53	2.1045321D 00	3.2369711D 02
38.00	53	2.1795157D 00	1.3174136D 03
38.10	53	2.0883509D 00	2.3536041D 01
38.20	54	2.1054566D 00	7.5206381D 01
38.30	54	2.1357806D 00	9.9249142D 02
38.40	54	2.1070160D 00	7.6162550D 02
38.50	54	2.0410965D 00	3.3859903D 02
38.60	54	2.0007303D 00	2.3859472D 02
38.70	54	2.0463584D 00	5.5685284D 02
38.80	54	2.0268381D 00	1.9763454D 02
38.90	54	2.0224786D 00	6.7696980D 01
39.00	55	2.0561277D 00	1.7512249D 01
39.10	55	2.0456501D 00	1.0496307D 01
39.20	55	2.0651622D 00	9.9018551D 02
39.30	55	1.9789800D 00	1.4088075D 02
39.40	55	1.9756279D 00	3.6618883D 02
39.50	55	2.0719133D 00	6.4853186D 02
39.60	55	2.0083921D 00	8.3918323D 01
39.70	55	2.0552592D 00	1.0064542D 02
39.80	55	2.0803304D 00	1.3355037D 00
39.90	56	2.1012907D 00	4.1342940D 02
40.00	56	2.0400693D 00	9.1319914D 01
40.10	56	2.0208726D 00	3.5084815D 01
40.20	56	2.0624131D 00	5.4888902D 02
40.30	56	2.0762510D 00	1.7995580D 02
40.40	56	2.0983222D 00	5.0312558D 01
40.50	56	2.1608798D 00	1.2927824D 02
40.60	56	2.1652197D 00	1.8365970D 00
40.70	57	2.1625550D 00	2.3828347D 02
40.80	57	2.1261149D 00	1.5157630D 01
40.90	57	2.1271953D 00	4.2520420D 00
41.00	57	2.2386016D 00	1.4145119D 03
41.10	57	2.1752365D 00	6.7958628D 01
41.20	57	2.2337406D 00	8.4548551D 01
41.30	57	2.2692773D 00	2.6016645D 02
41.40	57	2.3326420D 00	7.2412874D 02
41.50	58	2.2352852D 00	9.1666665D 01
41.60	58	2.2177782D 00	2.8504704D 00
41.70	58	2.2415835D 00	2.1001580D 02
41.80	58	2.2518173D 00	2.9380076D 02
41.90	58	2.2736006D 00	5.3975346D 01

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
42.00	58	2.3315221D 00	2.1030571D 02
42.10	58	2.3222238D 00	3.0561556D 02
42.20	58	2.3003601D 00	7.6846037D 02
42.30	59	2.2686254D 00	1.5683817D 02
42.40	59	2.2544270D 00	3.6094569D 01
42.50	59	2.3372937D 00	1.3654653D 03
42.60	59	2.2693691D 00	1.9844708D 01
42.70	59	2.3060749D 00	1.2656768D 02
42.80	59	2.3239314D 00	3.9430411D 02
42.90	59	2.3234236D 00	1.7939567D 03
43.00	59	2.2586259D 00	6.5967892D 02
43.10	59	2.2235168D 00	2.0521976D 02
43.20	60	2.2247798D 00	2.4675643D 02
43.30	60	2.2180241D 00	1.6558830D 02
43.40	60	2.2208493D 00	4.2184146D 01
43.50	60	2.2653331D 00	7.6271668D 02
43.60	60	2.2306979D 00	3.7452925D 02
43.70	60	2.1965000D 00	8.6340588D 02
43.80	60	2.1561582D 00	4.1565555D 02
43.90	61	2.1259079D 00	8.8040821D 01
44.00	61	2.1498744D 00	1.2636469D 03
44.10	61	2.1226197D 00	1.0627321D 02
44.20	61	2.1432248D 00	2.2146317D 02
44.30	61	2.1533073D 00	1.5433058D 03
44.40	61	2.1111519D 00	2.1609192D 03
44.50	61	2.0873116D 00	8.3263469D 02
44.60	61	2.0470307D 00	1.6680046D 02
44.70	62	2.0471667D 00	1.8767292D 02
44.80	62	2.0406629D 00	1.3706062D 02
44.90	62	2.0451062D 00	6.6417907D 00
45.00	62	2.0957944D 00	8.4262043D 02
45.10	62	2.1490468D 00	4.2131898D 03
45.20	62	2.0407289D 00	2.2981060D 03
45.30	62	2.0185628D 00	9.6623832D 02
45.40	62	1.9944158D 00	1.7419334D 02
45.50	63	2.0077704D 00	2.6631454D 02
45.60	63	2.0168335D 00	3.4688874D 01
45.70	63	2.0405730D 00	2.0941812D 02
45.80	63	2.0656836D 00	1.4881505D 03
45.90	63	2.0304822D 00	2.2406228D 03
46.00	63	2.0483970D 00	2.0272526D 03
46.10	63	2.0243283D 00	8.0386034D 02
46.20	63	2.0863648D 00	2.4539675D 03
46.30	64	2.0530957D 00	3.2393620D 02
46.40	64	2.0683814D 00	1.5387927D 02
46.50	64	2.1314608D 00	1.6964164D 03
46.60	64	2.0838784D 00	2.6211098D 03
46.70	64	2.1007265D 00	2.0939324D 03
46.80	64	2.1122785D 00	1.2229492D 03
46.90	64	2.0990600D 00	2.8661992D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
47.00	65	2.1258381D 00	3.9589686D 02
47.10	65	2.1516524D 00	3.6614527D 02
47.20	65	2.1718350D 00	2.1376847D 02
47.30	65	2.2316064D 00	2.6933257D 03
47.40	65	2.1600828D 00	2.7973772D 03
47.50	65	2.2064601D 00	2.5261075D 03
47.60	65	2.1886492D 00	5.6778521D 02
47.70	65	2.1992670D 00	3.9876087D 02
47.80	66	2.2302293D 00	2.3189190D 02
47.90	66	2.2421771D 00	1.5378695D 02
48.00	66	2.2967821D 00	1.2513860D 03
48.10	66	2.2709676D 00	6.5401565D 03
48.20	66	2.2352599D 00	3.2591443D 03
48.30	66	2.2650316D 00	2.4037599D 03
48.40	64	2.2381109D 00	5.6010003D 02
48.50	64	2.2586866D 00	4.3457795D 02
48.60	64	2.2796947D 00	4.4207757D 02
48.70	64	2.2792916D 00	1.5375399D 02
48.80	64	2.2837539D 00	2.7969541D 03
48.90	65	2.2260592D 00	1.7927600D 03
49.00	65	2.2647632D 00	3.3942431D 03
49.10	65	2.2379361D 00	1.2844601D 03
49.20	65	2.2271963D 00	5.7556937D 02
49.30	65	2.2529905D 00	9.8560074D 02
49.40	65	2.2482263D 00	7.1462997D 02
49.50	65	2.3021534D 00	4.2410274D 03
49.60	65	2.1904403D 00	1.9589381D 03
49.70	66	2.1735272D 00	2.0591547D 03
49.80	66	2.2139641D 00	2.4199172D 03
49.90	66	2.1612207D 00	6.4625807D 02
50.00	66	2.1710727D 00	5.0265501D 02
50.10	66	2.1832497D 00	1.0758132D 03
50.20	66	2.1639184D 00	4.3107887D 02
50.30	66	2.1453659D 00	3.6392633D 03
50.40	66	2.0873967D 00	2.0638783D 03
50.50	67	2.1096440D 00	3.7264431D 03
50.60	67	2.0940291D 00	8.3258615D 02
50.70	67	2.0768022D 00	2.6811811D 02
50.80	67	2.1043228D 00	8.1651762D 02
50.90	67	2.0945921D 00	6.9445131D 02
51.00	67	2.1315682D 00	1.9549715D 03
51.10	67	2.0286927D 00	1.7728998D 03
51.20	67	2.0100695D 00	2.1201497D 03
51.30	68	2.0749010D 00	4.4750125D 03
51.40	68	2.0176552D 00	5.8483588D 02
51.50	68	2.0393114D 00	1.0582870D 03
51.60	68	2.0647035D 00	1.5592359D 03
51.70	68	2.0475062D 00	4.9751994D 02
51.80	68	2.0249546D 00	2.0397974D 03
51.90	68	1.9891208D 00	9.3172982D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
52.00	68	2.0085017D 00	2.5412930D 03
52.10	69	2.0236448D 00	1.3528517D 03
52.20	69	2.0233012D 00	5.9959458D 02
52.30	69	2.0712477D 00	2.0159296D 03
52.40	69	2.0759607D 00	1.7926654D 03
52.50	69	2.1354461D 00	4.9323300D 03
52.60	69	2.0342175D 00	1.2597923D 03
52.70	69	2.0262606D 00	1.2260258D 03
52.80	69	2.1137857D 00	4.1322524D 03
52.90	69	2.0654800D 00	2.2078458D 02
53.00	70	2.1012911D 00	7.4455135D 02
53.10	70	2.1466261D 00	2.2068860D 03
53.20	70	2.1388763D 00	1.0592369D 03
53.30	70	2.1222094D 00	2.4237910D 03
53.40	70	2.1027734D 00	1.2731208D 03
53.50	70	2.1182287D 00	2.7111528D 03
53.60	70	2.1459031D 00	6.0391855D 02
53.70	70	2.1553649D 00	5.4161781D 02
53.80	71	2.2093563D 00	1.8462358D 03
53.90	71	2.2174294D 00	1.6853678D 03
54.00	71	2.2429655D 00	4.6242916D 03
54.10	71	2.1852629D 00	9.8144110D 02
54.20	71	2.1752653D 00	1.0710417D 03
54.30	71	2.2612770D 00	5.9971921D 03
54.40	71	2.2070847D 00	6.4744021D 02
54.50	71	2.2325067D 00	1.5861836D 03
54.60	71	2.2743988D 00	3.4224282D 03
54.70	72	2.2560085D 00	8.9836158D 02
54.80	72	2.2341849D 00	1.0608874D 03
54.90	72	2.2100451D 00	3.5704107D 02
55.00	72	2.2300401D 00	6.3610540D 02
55.10	72	2.2255057D 00	4.9596867D 02
55.20	72	2.2264663D 00	6.2546862D 02
55.30	72	2.2620832D 00	2.8617211D 03
55.40	72	2.2514098D 00	3.3467935D 03
55.50	73	2.2329720D 00	3.5681576D 03
55.60	73	2.2001254D 00	6.3730951D 02
55.70	73	2.1762876D 00	7.1427599D 02
55.80	73	2.2534639D 00	4.4726305D 03
55.90	73	2.1842488D 00	2.6839781D 02
56.00	73	2.1894258D 00	8.3580420D 02
56.10	73	2.2189780D 00	3.5811440D 03
56.20	73	2.1873914D 00	1.2027952D 03
56.30	73	2.1537027D 00	1.6317037D 03
56.40	74	2.1190273D 00	5.2397397D 02
56.50	74	2.1073758D 00	1.6906659D 03
56.60	74	2.1148051D 00	4.6020240D 02
56.70	74	2.1124179D 00	8.0353940D 02
56.80	74	2.1342269D 00	2.6554364D 03
56.90	74	2.1130031D 00	2.5098348D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
57.00	74	2.0889427D 00	2.3358659D 03
57.10	74	2.0662147D 00	5.1484961D 02
57.20	75	2.0372866D 00	2.8498106D 02
57.30	75	2.0901052D 00	2.6195207D 03
57.40	75	2.0510277D 00	7.9895807D 02
57.50	75	2.0528416D 00	1.4388349D 03
57.60	75	2.0881798D 00	5.1406459D 03
57.70	75	2.0577330D 00	6.9659811D 03
57.80	75	2.0388673D 00	9.3857526D 02
57.90	75	2.0119925D 00	3.1403101D 01
58.00	76	2.0058798D 00	6.5047835D 02
58.10	76	2.0241259D 00	2.3172809D 02
58.20	76	2.0333352D 00	5.0892419D 02
58.30	76	2.0563275D 00	2.4488786D 03
58.40	76	2.0431290D 00	3.4977560D 03
58.50	76	2.0329722D 00	2.8163623D 03
58.60	76	2.0413162D 00	3.8072080D 02
58.70	76	2.0218445D 00	2.7342005D 02
58.80	76	2.0458146D 00	1.9023651D 01
58.90	77	2.0653983D 00	4.0201365D 02
59.00	77	2.0728300D 00	5.3419460D 02
59.10	77	2.1202833D 00	4.1183963D 03
59.20	77	2.0671055D 00	3.1150456D 03
59.30	77	2.0962580D 00	2.1805378D 03
59.40	77	2.0871350D 00	1.0560098D 02
59.50	77	2.0923165D 00	1.1260841D 03
59.60	77	2.1228697D 00	7.2316450D 02
59.70	78	2.1407558D 00	6.5767020D 02
59.80	78	2.1588183D 00	2.2139025D 03
59.90	78	2.1584801D 00	1.7404128D 03
60.00	78	2.1683735D 00	4.9992886D 03
60.10	78	2.1718064D 00	1.0636155D 03
60.20	78	2.1517051D 00	1.1416035D 00
60.30	78	2.1736801D 00	1.0033220D 02
60.40	78	2.2063021D 00	6.1071166D 02
60.50	79	2.2073353D 00	6.3463346D 02
60.60	79	2.2501105D 00	5.1955369D 03
60.70	79	2.1808666D 00	1.5581645D 03
60.80	79	2.2067765D 00	1.3918113D 03
60.90	79	2.2032314D 00	2.5028713D 02
61.00	79	2.2368555D 00	1.8318599D 03
61.10	79	2.2277021D 00	1.7922313D 02
61.20	79	2.2395328D 00	1.5040514D 02
61.30	80	2.2380577D 00	9.5430331D 02
61.40	80	2.2098287D 00	2.3457794D 03
61.50	80	2.1857715D 00	1.6723352D 03
61.60	80	2.2260811D 00	1.2826699D 03
61.70	80	2.1864398D 00	1.1945958D 02
61.80	80	2.1950685D 00	3.8810232D 02
61.90	80	2.2218773D 00	2.1771206D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS*	I(180)
62.00	80	2.2073864D 00	7.3729242D 01
62.10	81	2.2345626D 00	2.7821550D 03
62.20	81	2.1492359D 00	6.3885930D 02
62.30	81	2.1543265D 00	1.9196792D 03
62.40	81	2.1558466D 00	5.8038490D 02
62.50	81	2.1338733D 00	5.3630292D 01
62.60	81	2.1547108D 00	5.1705492D 02
62.70	81	2.1589668D 00	1.5011993D 02
62.80	81	2.1416085D 00	9.6512489D 02
62.90	82	2.1021756D 00	3.1682545D 02
63.00	82	2.0725256D 00	2.4101520D 02
63.10	82	2.1176988D 00	2.3121759D 03
63.20	82	2.0714844D 00	1.3770694D 02
63.30	82	2.0740188D 00	3.1228742D 01
63.40	82	2.1014862D 00	4.5516323D 02
63.50	82	2.0819531D 00	3.3810803D 01
63.60	83	2.0951743D 00	2.8029528D 03
63.70	83	2.0218497D 00	1.1421465D 02
63.80	83	2.0206101D 00	6.6437349D 02
63.90	83	2.0424495D 00	9.9924384D 02
64.00	83	2.0238437D 00	3.3345335D 02
64.10	83	2.0503102D 00	5.7234187D 01
64.20	83	2.0630761D 00	4.2985696D 02
64.30	83	2.0486370D 00	2.0316933D 02
64.40	84	2.0146853D 00	4.1713568D 02
64.50	84	1.9957379D 00	1.8738439D 02
64.60	84	2.0483962D 00	2.4692341D 03
64.70	84	2.0213588D 00	4.5515186D 02
64.80	84	2.0353426D 00	2.0412969D 02
64.90	84	2.0779741D 00	2.1687269D 02
65.00	84	2.0673094D 00	4.5879015D 02
65.10	84	2.0704860D 00	1.4083410D 03
65.20	85	2.0299838D 00	2.6952101D 02
65.30	85	2.0336315D 00	2.8376604D 02
65.40	85	2.0737166D 00	1.4783500D 03
65.50	85	2.0683627D 00	2.8916846D 01
65.60	85	2.1030587D 00	3.3879606D 02
65.70	85	2.1296878D 00	7.2438133D 02
65.80	85	2.1252196D 00	2.9711648D 02
65.90	86	2.0995780D 00	6.5410987D 02
66.00	86	2.0886657D 00	1.6806299D 02
66.10	86	2.1353746D 00	1.5857610D 03
66.20	86	2.1263694D 00	7.3281151D 02
66.30	83	2.1434274D 00	2.9397422D 01
66.40	84	2.1907294D 00	1.1840028D 03
66.50	84	2.1812078D 00	8.8859199D 02
66.60	84	2.1755879D 00	1.9570115D 03
66.70	84	2.1521759D 00	3.2858243D 02
66.80	84	2.1518309D 00	2.6551298D 01
66.90	84	2.1882181D 00	2.1793019D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
67.00	84	2.1843616D 00	3.4612406D 02
67.10	84	2.2063362D 00	1.0214118D 01
67.20	85	2.2281852D 00	2.2505159D 03
67.30	85	2.2263033D 00	3.9178650D 02
67.40	85	2.1912570D 00	1.9398874D 03
67.50	85	2.1729023D 00	2.4773230D 02
67.60	85	2.2011064D 00	1.6262272D 03
67.70	85	2.1950201D 00	2.3881678D 02
67.80	85	2.1982319D 00	3.6044077D 01
67.90	85	2.2301792D 00	8.3698640D 02
68.00	86	2.2015094D 00	2.3260812D 03
68.10	86	2.1887774D 00	4.1694494D 03
68.20	86	2.1615390D 00	1.9357358D 03
68.30	86	2.1486147D 00	2.6116529D 02
68.40	86	2.1689776D 00	1.8937421D 03
68.50	86	2.1648910D 00	2.7398285D 02
68.60	86	2.1667925D 00	1.7624137D 02
68.70	86	2.1757121D 00	3.1020819D 03
68.80	87	2.2002300D 00	4.9196835D 03
68.90	87	2.1248766D 00	2.8192995D 03
69.00	87	2.0961699D 00	1.1352416D 03
69.10	87	2.1123423D 00	8.5300620D 02
69.20	87	2.1078303D 00	9.5704128D 02
69.30	87	2.1038521D 00	4.4357673D 02
69.40	87	2.1257449D 00	1.7446859D 03
69.50	87	2.0846242D 00	3.7880701D 03
69.60	88	2.0758752D 00	4.9020640D 03
69.70	88	2.0510720D 00	1.6895022D 03
69.80	88	2.0344822D 00	1.7066976D 02
69.90	88	2.0505096D 00	1.1309240D 03
70.00	88	2.0574716D 00	6.3119970D 02
70.10	88	2.0546095D 00	9.4032780D 01
70.20	88	2.0660681D 00	4.3784735D 03
70.30	88	2.0329246D 00	8.2644869D 03
70.40	89	2.0349366D 00	5.3258336D 03
70.50	89	2.0094472D 00	1.3249031D 03
70.60	89	2.0370449D 00	2.6416497D 03
70.70	89	2.0380491D 00	5.2976705D 02
70.80	89	2.0409507D 00	3.1149389D 02
70.90	89	2.0657756D 00	9.9556569D 02
71.00	89	2.0299085D 00	2.6543712D 03
71.10	89	2.0372091D 00	6.5940824D 03
71.20	90	2.0332548D 00	4.1378780D 03
71.30	90	2.0246449D 00	1.0899768D 03
71.40	90	2.0495443D 00	1.3470415D 03
71.50	90	2.0724446D 00	1.4585952D 03
71.60	90	2.1255730D 00	8.0840125D 03
71.70	90	2.0900450D 00	4.9044470D 03
71.80	90	2.0588305D 00	4.6989290D 03
71.90	90	2.0912069D 00	5.5197532D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
72.00	90	2.0739343D 00	1.7112283D 03
72.10	91	2.1437754D 00	1.0052985D 04
72.20	91	2.1220751D 00	1.6259109D C3
72.30	91	2.1303869D 00	1.8949506D 03
72.40	91	2.1520797D 00	1.2272290D 03
72,50	91	2.1711896D 00	1.2734838D 04
72.60	91	2.1259150D 00	6.4797429D 03
72.70	91	2.1420788D 00	3.4241305D 03
72.80	91	2.1335962D 00	4.8352660D 02
72.90	92	2.1599648D 00	5.9524281D 02
73.00	92	2.1882189D 00	1.6692197D 03
73.10	92	2.1812309D 00	9.0061950D 02
73.20	92	2.1896787D 00	5.6962217D 03
73.30	92	2.1513991D 00	5.2406103D 03
73.40	92	2.1893248D 00	9.2494573D 03
73.50	92	2.1682677D 00	2.2112880D 03
73.60	92	2.1767110D 00	1.5458942D 03
73.70	92	2.2066435D 00	1.8078108D 03
73.80	93	2.2084651D 00	1.7237229D 03
73.90	93	2.2156134D 00	5.9558426D 02
74.00	93	2.1670954D 00	4.0196393D 03
74.10	93	2.1613793D 00	4.7799679D 03
74.20	93	2.1840392D 00	6.2596837D 03
74.30	93	2.1610734D 00	1.4824335D 03
74.40	93	2.1749755D 00	1.7193366D 03
74.50	93	2.1970246D 00	3.9489513D 03
74.60	94	2.1766210D 00	1.6398955D 03
74.70	94	2.1676085D 00	5.1095628D 03
74.80	94	2.1226627D 00	2.7710986D 03
74.90	94	2.1482848D 00	7.0488595D 03
75.00	94	2.1249650D 00	1.8193975D 03
75.10	94	2.1196062D 00	1.0121928D 03
75.20	94	2.1429286D 00	2.6055609D 03
75.30	94	2.1370345D 00	4.3735121D 03
75.40	95	2.1340127D 00	9.3294988D 02
75.50	95	2.0790039D 00	4.6720700D 03
75.60	95	2.0643305D 00	4.4110759D 03
75.70	95	2.0968533D 00	5.8004709D 03
75.80	95	2.0726042D 00	1.9156411D 03
75.90	95	2.0725997D 00	8.8892662D 02
76.00	95	2.0947747D 00	3.6425649D 03
76.10	95	2.0701962D 00	2.2887433D 03
76.20	96	2.0524437D 00	7.0861909D 03
76.30	96	2.0176361D 00	3.1628057D 03
76.40	96	2.0364445D 00	8.4306323D 03
76.50	96	2.0316948D 00	2.4058431D 03
76.60	96	2.0306556D 00	1.3510212D 03
76.70	96	2.0562151D 00	3.5708819D 03
76.80	96	2.0559240D 00	4.1838625D 03
76.90	96	2.0616506D 00	7.4615389D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
77.00	97	2.0102887D 00	2.3499742D 03
77.10	97	2.0014402D 00	2.1178124D 03
77.20	97	2.0534936D 00	8.4195506D 03
77.30	97	2.0293354D 00	1.8743953D 03
77.40	97	2.0428022D 00	1.9762980D 03
77.50	97	2.0763741D 00	7.2419560D 03
77.60	97	2.0592180D 00	3.6246311D 03
77.70	97	2.0471615D 00	5.1544594D 03
77.80	98	2.0273517D 00	1.5635054D 03
77.90	98	2.0449932D 00	4.4883168D 03
78.00	98	2.0620554D 00	1.1501523D 03
78.10	98	2.0725311D 00	8.3521868D 02
78.20	98	2.1024817D 00	2.9870562D 03
78.30	98	2.1107721D 00	6.8898253D 03
78.40	98	2.1412388D 00	3.1376413D 03
78.50	98	2.0852745D 00	2.9990092D 03
78.60	99	2.0803656D 00	2.4832348D 03
78.70	99	2.1421607D 00	8.0427747D 03
78.80	99	2.1213973D 00	1.0711338D 03
78.90	99	2.1346114D 00	1.1910423D 03
79.00	99	2.1713222D 00	5.9484309D 03
79.10	99	2.1531507D 00	3.4178439D 03
79.20	99	2.1468045D 00	4.3223618D 03
79.30	99	2.1306040D 00	1.4969669D 03
79.40	100	2.1403801D 00	4.2661256D 03
79.50	100	2.1608650D 00	1.9051489D 03
79.60	100	2.1694114D 00	1.8904670D 03
79.70	100	2.1873073D 00	4.2652869D 03
79.80	100	2.1887310D 00	6.6885314D 03
79.90	100	2.2185348D 00	1.0611534D 04
80.00	100	2.1617111D 00	1.0808768D 03
80.10	100	2.1496458D 00	6.5058069D 02
80.20	101	2.2034912D 00	7.7219765D 03
80.30	101	2.1779936D 00	1.5444570D 03
80.40	101	2.1770153D 00	1.7143726D 03
80.50	101	2.2019454D 00	9.5752434D 03
80.60	101	2.1667946D 00	5.3617006D 03
80.70	101	2.1600231D 00	3.4411036D 03
80.80	101	2.1359575D 00	5.0326732D 02
80.90	102	2.1337187D 00	2.4042728D 03
81.00	102	2.1482513D 00	5.4816329D 02
81.10	102	2.1502429D 00	8.3006811D 02
81.20	102	2.1495669D 00	2.1561415D 03
81.30	102	2.1380408D 00	7.6159312D 03
81.40	102	2.1245471D 00	1.0562507D 04
81.50	102	2.1039572D 00	1.7391910D 03
81.60	102	2.0829834D 00	9.8280059D 02
81.70	103	2.1189648D 00	3.8483629D 03
81.80	103	2.1041649D 00	1.5628317D 03
81.90	103	2.0952889D 00	1.0776768D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
82.00	103	2.1139481D 00	7.4582490D 03
82.10	103	2.0662401D 00	3.0393006D 03
82.20	103	2.0673408D 00	4.0723222D 03
82.30	103	2.0420501D 00	4.6270037D 02
82.40	104	2.0363934D 00	1.6773561D 03
82.50	104	2.0529863D 00	1.3414455D 03
82.60	104	2.0599642D 00	1.8339369D 03
82.70	101	2.0544321D 00	2.9530082D 03
82.80	101	2.0433094D 00	6.6033008D 03
82.90	101	2.0280025D 00	5.4586922D 03
83.00	102	2.0301139D 00	1.0010890D 03
83.10	102	2.0118103D 00	3.0045484D 01
83.20	102	2.0320435D 00	7.1924488D 02
83.30	102	2.0469170D 00	1.1583171D 03
83.40	102	2.0434685D 00	8.3316419D 02
83.50	102	2.0691763D 00	9.0885666D 03
83.60	102	2.0273857D 00	2.5527773D 03
83.70	102	2.0411166D 00	4.3089174D 03
83.80	103	2.0294435D 00	3.4486411D 01
83.90	103	2.0315116D 00	1.0928398D 03
84.00	103	2.0561918D 00	6.3002439D 02
84.10	103	2.0738223D 00	4.6999475D 02
84.20	103	2.0703261D 00	6.8475154D 02
84.30	103	2.0647549D 00	4.6189054D 03
84.40	103	2.0545794D 00	5.2277039D 03
84.50	103	2.0821985D 00	2.5488614D 03
84.60	104	2.0699260D 00	1.2998901D 02
84.70	104	2.0878905D 00	1.4068225D 02
84.80	104	2.1195283D 00	1.4380733D 03
84.90	104	2.1190206D 00	3.1340865D 02
85.00	104	2.1476271D 00	6.8117218D 03
85.10	104	2.0988481D 00	3.8122924D 03
85.20	104	2.1206851D 00	4.0482552D 03
85.30	104	2.1216432D 00	7.7188876D 02
85.40	105	2.1264692D 00	4.9742604D 02
85.50	105	2.1508740D 00	8.0007131D 02
85.60	105	2.1708097D 00	1.1124368D 03
85.70	105	2.1606932D 00	6.8794127D 02
85.80	105	2.1484381D 00	2.4279157D 03
85.90	105	2.1323314D 00	1.8781697D 03
86.00	105	2.1696922D 00	2.3238695D 03
86.10	105	2.1498317D 00	1.9723162D 02
86.20	106	2.1599777D 00	7.4504278D 01
86.30	106	2.1895916D 00	7.1805979D 02
86.40	106	2.1820501D 00	3.4497348D 02
86.50	106	2.2036719D 00	5.9192547D 03
86.60	106	2.1397024D 00	1.7131129D 03
86.70	106	2.1478768D 00	3.5264460D 03
86.80	106	2.1525520D 00	3.3574261D 02
86.90	106	2.1560242D 00	1.8211396D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
87.00	107	2.1603331D 00	5.0663703D 02
87.10	107	2.1740060D 00	3.8516870D 02
87.20	107	2.1530940D 00	3.9736390D 02
87.30	107	2.1313310D 00	2.3386665D 02
87.40	107	2.1048549D 00	1.9641911D 03
87.50	107	2.1418946D 00	5.1344457D 03
87.60	107	2.1113034D 00	1.8143646D 01
87.70	107	2.1108462D 00	1.3800886D 02
87.80	107	2.1319601D 00	1.2016496D 03
87.90	108	2.1168424D 00	2.4819847D 02
88.00	108	2.1360966D 00	3.9244997D 03
88.10	108	2.0648118D 00	5.4824130D 01
88.20	108	2.0613358D 00	8.1263482D 02
88.30	108	2.0732722D 00	1.9189660D 03
88.40	108	2.0661374D 00	8.6042092D 02
88.50	108	2.0712035D 00	2.6985283D 02
88.60	108	2.0835098D 00	2.0089995D 03
88.70	109	2.0604266D 00	3.4781347D 02
88.80	109	2.0370178D 00	5.5018829D 02
88.90	109	2.0163223D 00	8.3787853D 01
89.00	109	2.0566880D 00	3.3057580D 03
89.10	109	2.0337010D 00	5.0785996D 02
89.20	109	2.0363242D 00	2.5079416D 02
89.30	109	2.0587829D 00	7.7904199D 02
89.40	109	2.0460293D 00	2.7328985D 03
89.50	110	2.0692480D 00	2.9793967D 03
89.60	110	2.0093113D 00	3.3285357D 02
89.70	110	2.0086091D 00	5.4027256D 02
89.80	110	2.0341438D 00	1.2205584D 03
89.90	110	2.0373106D 00	2.6669239D 02
90.00	110	2.0476914D 00	2.4236370D 02
90.10	110	2.0686717D 00	1.8576055D 03
90.20	110	2.0524919D 00	2.7616995D 03
90.30	110	2.0390341D 00	2.7078035D 03
90.40	111	2.0277453D 00	4.5743577D 02
90.50	111	2.0681263D 00	4.6075086D 03
90.60	111	2.0646144D 00	9.3505842D 01
90.70	111	2.0747399D 00	1.4238946D 01
90.80	111	2.1012095D 00	1.4101562D 03
90.90	111	2.0934734D 00	2.6326961D 03
91.00	111	2.1076029D 00	3.8095713D 03
91.10	111	2.0759231D 00	1.9778658D 03
91.20	112	2.0773869D 00	1.9874453D 02
91.30	112	2.1071712D 00	3.5479567D 03
91.40	112	2.1184226D 00	8.9861529D 02
91.50	112	2.1266092D 00	3.6155646D 01
91.60	112	2.1498318D 00	4.9544696D 03
91.70	112	2.1340330D 00	2.9100038D 03
91.80	112	2.1279069D 00	2.9120915D 03
91.90	112	2.1169232D 00	7.8572588D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
92.00	113	2.1453505D 00	1.4504654D 03
92.10	113	2.1498934D 00	1.5161713D 03
92.20	113	2.1568184D 00	9.2447364D 02
92.30	113	2.1729022D 00	4.1443642D 02
92.40	113	2.1573419D 00	6.4830938D 03
92.50	113	2.1597587D 00	9.5539162D 03
92.60	113	2.1409041D 00	2.7960967D 03
92.70	113	2.1355318D 00	1.7434519D 02
92.80	114	2.1554527D 00	1.9237881D 03
92.90	114	2.1648790D 00	5.5683405D 02
93.00	114	2.1595529D 00	2.6169232D 02
93.10	114	2.1723977D 00	3.7366656D 03
93.20	114	2.1434939D 00	5.1410650D 03
93.30	114	2.1385424D 00	8.0097659D 03
93.40	114	2.1199523D 00	2.7817348D 03
93.50	114	2.1339174D 00	2.3280515D 03
93.60	115	2.1377157D 00	1.3892688D 03
93.70	115	2.1367539D 00	9.1815406D 02
93.80	115	2.1372916D 00	6.3749134D 02
93.90	115	2.1096787D 00	4.7727519D 03
94.00	115	2.1052473D 00	8.8806153D 03
94.10	115	2.0885707D 00	4.9607056D 03
94.20	115	2.0770440D 00	1.5407409D 03
94.30	116	2.0885664D 00	5.0709929D 03
94.40	116	2.0991461D 00	2.8300739D 03
94.50	116	2.0862205D 00	1.2491927D 03
94.60	116	2.0945430D 00	7.2291201D 03
94.70	116	2.0598872D 00	2.3519909D 03
94.80	116	2.0592517D 00	7.7738231D 03
94.90	116	2.0380890D 00	2.0248502D 03
95.00	116	2.0493825D 00	1.2927484D 03
95.10	117	2.0564295D 00	1.5988283D 03
95.20	117	2.0578405D 00	3.0451936D 03
95.30	117	2.0545018D 00	9.7223943D 01
95.40	117	2.0287178D 00	8.1227657D 03
95.50	117	2.0278120D 00	1.3113215D 04
95.60	117	2.0249021D 00	6.3509670D 03
95.70	117	2.0170356D 00	1.2881918D 03
95.80	117	2.0300947D 00	1.6789798D 03
95.90	118	2.0510496D 00	2.3135721D 03
96.00	118	2.0419260D 00	1.6013873D 03
96.10	118	2.0569277D 00	5.3109706D 03
96.20	118	2.0299372D 00	1.2560060D 04
96.30	118	2.0431107D 00	1.3959167D 04
96.40	118	2.0293822D 00	4.7111028D 03
96.50	118	2.0543117D 00	6.8650340D 03
96.60	119	2.0615298D 00	3.1217859D 03
96.70	119	2.0708455D 00	4.4385700D 03
96.80	119	2.0691307D 00	9.0598850D 01
96.90	119	2.0505997D 00	5.0697220D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
97.00	119	2.0542700D 00	7.9764760D 03
97.10	119	2.0718990D 00	7.6758348D 03
97.20	119	2.0704029D 00	2.2789722D 03
97.30	119	2.0866811D 00	2.8224506D 03
97.40	120	2.1148255D 00	6.2680136D 03
97.50	120	2.1074298D 00	5.0766125D 03
97.60	120	2.1239475D 00	1.0337501D 04
97.70	120	2.0856517D 00	8.2187626D 03
97.80	117	2.1186057D 00	1.3252563D 04
97.90	117	2.1104197D 00	2.7296636D 03
98.00	118	2.1573893D 00	1.6916755D 04
98.10	118	2.1436776D 00	2.1137879D 03
98.20	118	2.1530944D 00	6.6535941D 03
98.30	118	2.1456618D 00	1.5247860D 03
98.40	118	2.1248193D 00	7.1865068D 03
98.50	118	2.1205500D 00	9.4206296D 03
98.60	118	2.1459038D 00	1.0797335D 04
98.70	118	2.1397206D 00	2.3548546D 03
98.80	119	2.1495145D 00	1.8102006D 03
98.90	119	2.1737871D 00	5.8566877D 03
99.00	119	2.1588002D 00	4.4705420D 03
99.10	119	2.1649836D 00	8.3692361D 03
99.20	119	2.1219181D 00	5.3500018D 03
99.30	119	2.1428945D 00	1.4508370D 04
99.40	119	2.1341775D 00	5.4067722D 03
99.50	119	2.1380219D 00	5.5969052D 03
99.60	120	2.1492926D 00	4.6299909D 03
99.70	120	2.1519043D 00	1.0142738D 04
99.80	120	2.1353428D 00	1.3993379D 03
99.90	120	2.1178477D 00	1.2706829D 04
100.00	120	2.0943878D 00	4.3404830D 03
100.10	120	2.1200424D 00	1.0893765D 04
100.20	120	2.1039878D 00	2.3916580D 03
100.30	120	2.1039479D 00	2.3657868D 03
100.40	121	2.1214806D 00	9.4501852D 03
100.50	121	2.0991037D 00	9.7290709D 03
100.60	121	2.0946104D 00	1.3499997D 04
100.70	121	2.0562127D 00	5.5254691D 03
100.80	121	2.0653014D 00	1.1598665D 04
100.90	121	2.0640757D 00	3.3002217D 03
101.00	121	2.0641543D 00	2.0217621D 03
101.10	121	2.0694917D 00	2.3511505D 03
101.20	122	2.0706499D 00	1.0551560D 04
101.30	122	2.0541191D 00	3.3498842D 03
101.40	122	2.0292857D 00	7.6417665D 03
101.50	122	2.0178161D 00	5.4892034D 03
101.60	122	2.0525738D 00	1.6131696D 04
101.70	122	2.0383905D 00	3.8176941D 03
101.80	122	2.0389893D 00	2.5304566D 03
101.90	122	2.0584168D 00	9.6455333D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
102.00	123	2.0374054D 00	7.7559743D 03
102.10	123	2.0332357D 00	8.1455367D 03
102.20	123	2.0100293D 00	2.9385847D 03
102.30	123	2.0188282D 00	7.0062466D 03
102.40	123	2.0325680D 00	4.4698089D 03
102.50	123	2.0426727D 00	4.3423011D 03
102.60	123	2.0500861D 00	4.3993728D 03
102.70	123	2.0577004D 00	1.5616142D 04
102.80	124	2.0499240D 00	3.0048539D 03
102.90	124	2.0346645D 00	3.9110129D 03
103.00	124	2.0304505D 00	2.1311190D 03
103.10	124	2.0760716D 00	1.3277900D 04
103.20	124	2.0692447D 00	4.3377191D 03
103.30	124	2.0744467D 00	2.2292237D 03
103.40	124	2.0985964D 00	1.0198788D 04
103.50	124	2.0799376D 00	1.2974366D 04
103.60	124	2.0825772D 00	1.2744082D 04
103.70	125	2.0702005D 00	3.1653319D 03
103.80	125	2.0790896D 00	6.2845217D 03
103.90	125	2.0990803D 00	2.3417195D 03
104.00	125	2.1143237D 00	2.4398693D 03
104.10	125	2.1190777D 00	1.8251972D 03
104.20	125	2.1280038D 00	1.2791681D 04
104.30	125	2.1242869D 00	3.3754329D 03
104.40	125	2.1133163D 00	4.7511641D 03
104.50	126	2.1088988D 00	2.4652542D 03
104.60	126	2.1539074D 00	1.7483262D 04
104.70	126	2.1424142D 00	4.5455717D 03
104.80	126	2.1441344D 00	2.9901257D 03
104.90	126	2.1615151D 00	1.1120088D 04
105.00	126	2.1347805D 00	8.9561000D 03
105.10	126	2.1394129D 00	7.7758524D 03
105.20	126	2.1255871D 00	1.0302192D 03
105.30	127	2.1279508D 00	2.2785215D 03
105.40	127	2.1423063D 00	2.2100897D 03
105.50	127	2.1522564D 00	4.2285286D 03
105.60	127	2.1437190D 00	2.7161429D 03
105.70	127	2.1433289D 00	1.7244870D 04
105.80	127	2.1421583D 00	3.7956812D 03
105.90	127	2.1210665D 00	2.5770787D 03
106.00	127	2.1094353D 00	6.7872562D 02
106.10	128	2.1439674D 00	9.4383869D 03
106.20	128	2.1301466D 00	2.0921947D 03
106.30	128	2.1229272D 00	1.5762439D 03
106.40	128	2.1282019D 00	7.4212601D 03
106.50	128	2.0905129D 00	1.0367656D 04
106.60	128	2.0947458D 00	1.1925813D 04
106.70	128	2.0775587D 00	1.2957688D 03
106.80	128	2.0746129D 00	2.8829488D 03
106.90	129	2.0840849D 00	1.5387363D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
107.00	129	2.0928746D 00	2.4807228D 03
107.10	129	2.0767047D 00	7.2708623D 02
107.20	129	2.0710677D 00	1.0504509D 04
107.30	129	2.0593418D 00	2.0321981D 04
107.40	129	2.0514570D 00	5.0538573D 03
107.50	129	2.0373029D 00	6.6651841D 02
107.60	129	2.0581212D 00	6.1946254D 03
107.70	130	2.0588270D 00	4.0415260D 03
107.80	130	2.0529991D 00	2.0349861D 03
107.90	130	2.0565720D 00	8.4691355D 03
108.00	130	2.0208620D 00	4.2021391D 03
108.10	130	2.0305109D 00	7.7900063D 03
108.20	130	2.0219497D 00	6.7274141D 02
108.30	130	2.0231632D 00	4.2906177D 02
108.40	130	2.0352362D 00	6.3600073D 02
108.50	131	2.0513564D 00	3.2701056D 03
108.60	131	2.0384625D 00	5.3204490D 02
108.70	131	2.0376183D 00	1.1357710D 04
108.80	131	2.0185582D 00	1.0288099D 04
108.90	131	2.0413433D 00	3.8309902D 03
109.00	131	2.0319075D 00	9.4273549D 01
109.10	131	2.0734177D 00	9.4992104D 03
109.20	131	2.0652008D 00	1.4718948D 03
109.30	132	2.0651621D 00	9.4566457D 02
109.40	132	2.0713543D 00	3.1362020D 03
109.50	132	2.0438804D 00	3.0128611D 03
109.60	132	2.0578359D 00	9.6249858D 03
109.70	132	2.0645121D 00	8.9115150D 02
109.80	132	2.0721965D 00	1.1231515D 03
109.90	132	2.0868126D 00	1.1715294D 03
110.00	133	2.1083801D 00	2.1103009D 03
110.10	133	2.0963333D 00	8.3316799D 01
110.20	133	2.0952189D 00	3.4059393D 03
110.30	133	2.0794486D 00	2.5385036D 03
110.40	133	2.1143716D 00	7.6275267D 03
110.50	133	2.1045880D 00	2.6506065D 02
110.60	133	2.1162703D 00	3.9324279D 02
110.70	133	2.1375958D 00	2.9464162D 03
110.80	134	2.1366151D 00	1.6871877D 03
110.90	134	2.1380649D 00	4.0676535D 03
111.00	134	2.1121186D 00	4.9601110D 02
111.10	134	2.1152700D 00	3.1347678D 03
111.20	134	2.1278858D 00	1.3633039D 03
111.30	134	2.1327874D 00	6.5911359D 01
111.40	134	2.1402321D 00	4.4930085D 01
111.50	134	2.1584490D 00	3.7112366D 03
111.60	135	2.1398514D 00	1.2752497D 03
111.70	135	2.1294410D 00	2.9560266D 03
111.80	135	2.1097302D 00	1.3959468D 03
111.90	135	2.1415428D 00	6.4380177D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
112.00	135	2.1242277D 00	8.1699795D 01
112.10	135	2.1276683D 00	1.5161879D 02
112.20	135	2.1395547D 00	9.7387397D 02
112.30	136	2.1321404D 00	3.0070980D 03
112.40	136	2.1276506D 00	2.3497597D 03
112.50	136	2.0935202D 00	1.0198691D 03
112.60	136	2.0887888D 00	1.9125794D 03
112.70	133	2.1002978D 00	1.6822679D 03
112.80	133	2.1004097D 00	8.0365401D 02
112.90	133	2.0968518D 00	4.0825522D 02
113.00	134	2.1095418D 00	3.2529964D 03
113.10	134	2.0851574D 00	2.3452198D 03
113.20	134	2.0701318D 00	1.0994576D 03
113.30	134	2.0509331D 00	1.6928887D 02
113.40	134	2.0765389D 00	6.4964055D 03
113.50	134	2.0615145D 00	5.5975032D 02
113.60	134	2.0621265D 00	3.4912682D 02
113.70	134	2.0672410D 00	1.6154385D 03
113.80	135	2.0580971D 00	5.1849521D 03
113.90	135	2.0579238D 00	2.1879430D 03
114.00	135	2.0247569D 00	4.9732156D 02
114.10	135	2.0213135D 00	1.5773295D 02
114.20	135	2.0380340D 00	3.7589792D 03
114.30	135	2.0460276D 00	4.5987904D 03
114.40	135	2.0388820D 00	3.0837265D 02
114.50	135	2.0544306D 00	5.1071137D 03
114.60	136	2.0315156D 00	6.8831528D 03
114.70	136	2.0235059D 00	3.3549101D 03
114.80	136	2.0118882D 00	2.5190087D 02
114.90	136	2.0359225D 00	3.9521390D 03
115.00	136	2.0370490D 00	4.0166888D 02
115.10	136	2.0446181D 00	6.3005801D 02
115.20	136	2.0506981D 00	4.9933251D 02
115.30	136	2.0472224D 00	6.3893384D 03
115.40	137	2.0640808D 00	1.9411993D 03
115.50	137	2.0317732D 00	4.0661829D 03
115.60	137	2.0342787D 00	3.6037790D 02
115.70	137	2.0573871D 00	4.5089989D 03
115.80	137	2.0703245D 00	9.3724037D 02
115.90	137	2.0712953D 00	1.7979685D 02
116.00	137	2.0922345D 00	4.4862051D 03
116.10	137	2.0713285D 00	5.8260468D 03
116.20	138	2.0733366D 00	7.3587918D 03
116.30	138	2.0661137D 00	3.1169993D 03
116.40	138	2.0866235D 00	1.3046881D 03
116.50	138	2.0982986D 00	1.8434420D 03
116.60	138	2.1091086D 00	2.3460365D 03
116.70	138	2.1114227D 00	3.4464482D 01
116.80	138	2.1087741D 00	8.4874385D 03
116.90	138	2.1439601D 00	3.9087860D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
117.00	139	2.1024227D 00	4.0907730D 03
117.10	139	2.1037515D 00	9.7067125D 02
117.20	139	2.1223102D 00	6.5422949D 03
117.30	139	2.1363858D 00	2.8767398D 03
117.40	139	2.1317603D 00	3.0067736D 03
117.50	139	2.1483435D 00	4.1590433D 03
117.60	139	2.1190852D 00	1.0049501D 04
117.70	139	2.1261502D 00	1.2496371D 04
117.80	140	2.1150399D 00	2.6420669D 03
117.90	140	2.1258822D 00	1.0127957D 03
118.00	140	2.1431351D 00	1.3836625D 03
118.10	140	2.1401557D 00	2.8529009D 03
118.20	140	2.1300372D 00	1.2305584D 03
118.30	140	2.1190298D 00	7.5265807D 03
118.40	140	2.1204511D 00	1.9429793D 04
118.50	140	2.1074979D 00	1.0375766D 04
118.60	140	2.1026865D 00	2.8506284D 03
118.70	141	2.1117421D 00	6.2729984D 03
118.80	141	2.1230879D 00	3.7127879D 03
118.90	141	2.1096350D 00	2.8730205D 03
119.00	141	2.1184763D 00	3.7141528D 03
119.10	141	2.0779184D 00	5.6423830D 03
119.20	141	2.0874566D 00	1.5615050D 04
119.30	141	2.0706174D 00	6.0465216D 03
119.40	141	2.0757129D 00	1.4712083D 03
119.50	142	2.0821578D 00	4.2966299D 03
119.60	142	2.0853268D 00	8.5535522D 03
119.70	142	2.0679246D 00	2.0671491D 03
119.80	142	2.0527824D 00	9.6651013D 03
119.90	142	2.0443484D 00	1.5009182D 04
120.00	142	2.0446683D 00	8.9761152D 03
120.10	142	2.0380675D 00	2.2052730D 03
120.20	142	2.0443135D 00	5.0244421D 03
120.30	143	2.0597670D 00	5.4879076D 03
120.40	143	2.0470971D 00	9.3766894D 03
120.50	143	2.0577986D 00	2.5643983D 03
120.60	143	2.0170541D 00	8.2446457D 03
120.70	143	2.0349682D 00	2.2692475D 04
120.80	143	2.0221023D 00	5.3759402D 03
120.90	143	2.0302098D 00	1.8279714D 03
121.00	143	2.0392183D 00	2.0337922D 03
121.10	144	2.0492901D 00	8.1112946D 03
121.20	144	2.0351348D 00	4.6496793D 03
121.30	144	2.0248124D 00	9.1035767D 03
121.40	144	2.0203955D 00	1.2999562D 04
121.50	144	2.0377197D 00	1.8457573D 04
121.60	144	2.0357638D 00	5.4025565D 03
121.70	144	2.0449323D 00	6.3956951D 03
121.80	144	2.0666622D 00	8.5275420D 03
121.90	145	2.0594085D 00	9.8040741D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
122.00	145	2.0766138D 00	3.0756365D 03
122.10	145	2.0419871D 00	3.0776724D 03
122.20	145	2.0641999D 00	1.8245034D 04
122.30	145	2.0623819D 00	7.8133275D 03
122.40	145	2.0771483D 00	3.1326395D 03
122.50	145	2.0854332D 00	4.5103314D 03
122.60	145	2.1000995D 00	1.7342346D 04
122.70	146	2.0877889D 00	8.4195148D 03
122.80	146	2.0788547D 00	1.1520614D 04
122.90	146	2.0761174D 00	9.4826248D 03
123.00	146	2.1040976D 00	1.6468915D 04
123.10	146	2.1023013D 00	3.2347880D 03
123.20	146	2.1105475D 00	3.7362266D 03
123.30	146	2.1308552D 00	7.1131791D 03
123.40	147	2.1220616D 00	1.6711033D 04
123.50	147	2.1394515D 00	3.0129561D 03
123.60	147	2.0998993D 00	1.3813156D 04
123.70	147	2.1147477D 00	2.0845947D 04
123.80	147	2.1180107D 00	7.8501647D 03
123.90	147	2.1492846D 00	2.0681879D 04
124.00	147	2.1311873D 00	2.5850210D 03
124.10	147	2.1423713D 00	1.4784415D 04
124.20	148	2.1251273D 00	8.9508546D 03
124.30	148	2.1099909D 00	9.7615327D 03
124.40	148	2.1014849D 00	7.7910597D 03
124.50	148	2.1294095D 00	2.8280573D 04
124.60	148	2.1183990D 00	7.6091448D 03
124.70	148	2.1188039D 00	6.5952703D 03
124.80	148	2.1303665D 00	1.1148596D 04
124.90	148	2.1154453D CO	1.8002179D 04
125.00	149	2.1312506D 00	6.4973885D 03
125.10	149	2.0828253D 00	5.8359636D 03
125.20	149	2.0872756D 00	9.9658796D 03
125.30	149	2.0910700D 00	7.3477465D 03
125.40	149	2.0960330D 00	1.2430693D 04
125.50	149	2.0890828D 00	4.2168458D 03
125.60	149	2.0956716D 00	2.4240951D 04
125.70	150	2.0754606D 00	1.5212499D 04
125.80	150	2.0584095D 00	1.0477545D 04
125.90	150	2.0476741D 00	6.5269679D 03
126.00	150	2.0782483D 00	2.6183661D 04
126.10	150	2.0619924D 00	4.3674621D 03
126.20	150	2.0587716D 00	3.9141439D 03
126.30	150	2.0640710D 00	6.2128790D 03
126.40	150	2.0476294D 00	2.1237727D 04
126.50	151	2.0652171D 00	1.3333236D 04
126.60	151	2.0223658D 00	8.0949585D 03
126.70	151	2.0256970D 00	1.1204409D 04
126.80	151	2.0356432D 00	7.7815159D 03
126.90	148	2.0436892D 00	8.3393188D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
127.00	148	2.0368640D 00	2.9726989D 03
127.10	148	2.0454907D 00	2.0509269D 04
127.20	149	2.0287042D 00	1.2404481D 04
127.30	149	2.0206729D 00	9.9439454D 03
127.40	149	2.0146725D 00	4.0234273D 03
127.50	149	2.0540585D 00	3.4070934D 04
127.60	149	2.0422614D 00	8.2047364D 03
127.70	149	2.0447836D 00	8.1104895D 03
127.80	149	2.0506715D 00	9.2007157D 03
127.90	149	2.0383492D 00	2.2757069D 04
128.00	150	2.0528573D 00	2.0748658D 04
128.10	150	2.0312053D 00	2.9844713D 03
128.20	150	2.0387389D 00	4.0925817D 03
128.30	150	2.0550960D 00	3.8452220D 03
128.40	150	2.0715158D 00	7.5856219D 03
128.50	150	2.0673560D 00	3.6224844D 03
128.60	150	2.0805023D 00	2.6233930D 04
128.70	151	2.0661548D 00	1.8761213D 04
128.80	151	2.0678260D 00	1.0460545D 04
128.90	151	2.0655030D 00	3.6432832D 03
129.00	151	2.1077271D 00	3.0797414D 04
129.10	151	2.0989815D 00	6.1519206D 03
129.20	151	2.1029845D 00	4.2221993D 03
129.30	151	2.1055243D 00	3.2892425D 03
129.40	151	2.0939453D 00	1.8308804D 04
129.50	151	2.1059122D 00	2.5007607D 04
129.60	152	2.0949833D 00	4.9255940D 03
129.70	152	2.1007714D 00	5.0398741D 03
129.80	152	2.1139231D 00	4.6360699D 03
129.90	152	2.1300334D 00	9.2887723D 03
130.00	152	2.1202042D 00	2.5824382D 03
130.10	152	2.1295169D 00	2.2385128D 04
130.20	152	2.1086349D 00	1.0297790D 04
130.30	152	2.1157556D 00	8.6601978D 03
130.40	153	2.1082108D 00	1.5029992D 03
130.50	153	2.1443761D 00	2.9090879D 04
130.60	153	2.1292903D 00	6.3984056D 03
130.70	153	2.1284477D 00	7.7538781D 03
130.80	153	2.1193794D 00	3.9551314D 03
130.90	153	2.1010330D 00	1.7610213D 04
131.00	153	2.1077124D 00	2.2813103D 04
131.10	153	2.0981027D 00	1.5913401D 03
131.20	154	2.0981413D 00	1.4200866D 03
131.30	154	2.1033703D 00	9.0072692D 02
131.40	154	2.1156062D 00	6.0771281D 03
131.50	154	2.0979239D 00	2.2612563D 03
131.60	154	2.0999913D 00	2.1178639D 04
131.70	154	2.0698396D 00	1.0307031D 04
131.80	154	2.0808891D 00	1.2677307D 04
131.90	154	2.0675734D 00	1.7250931D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
132.00	155	2.1009706D 00	2.8138578D 04
132.10	155	2.0794431D 00	4.2124381D 03
132.20	155	2.0771647D 00	3.5236501D 03
132.30	155	2.0619991D 00	8.5798423D 02
132.40	155	2.0409271D 00	8.0493779D 03
132.50	155	2.0436206D 00	1.8615884D 04
132.60	155	2.0404767D 00	3.8189689D 03
132.70	155	2.0403262D 00	2.1176959D 03
132.80	156	2.0433893D 00	2.0474533D 03
132.90	156	2.0578842D 00	8.8548694D 03
133.00	156	2.0416486D 00	1.2416577D 03
133.10	156	2.0454896D 00	1.7021601D 04
133.20	156	2.0195424D 00	9.4824702D 02
133.30	156	2.0370390D 00	1.1038796D 04
133.40	156	2.0249853D 00	5.0925650D 02
133.50	156	2.0533247D 00	1.9749329D 04
133.60	156	2.0411279D 00	3.0879587D 03
133.70	157	2.0448496D 00	7.4242961D 03
133.80	157	2.0337479D 00	1.3316528D 02
133.90	157	2.0189434D 00	5.9820786D 03
134.00	157	2.0242273D 00	1.2237018D 04
134.10	157	2.0347593D 00	1.1130269D 03
134.20	157	2.0402105D 00	4.7999116D 02
134.30	157	2.0457367D 00	4.7144050D 01
134.40	157	2.0652623D 00	5.0613309D 03
134.50	158	2.0540431D 00	3.4737841D 03
134.60	158	2.0624599D 00	1.0106364D 04
134.70	158	2.0408390D 00	1.1066361D 04
134.80	158	2.0702416D 00	1.6305048D 04
134.90	158	2.0632970D 00	5.8383057D 02
135.00	158	2.0775370D 00	2.6891667D 03
135.10	158	2.0830697D 00	2.8225830D 03
135.20	159	2.0905033D 00	4.4742644D 03
135.30	159	2.0822063D 00	2.1606904D 03
135.40	159	2.0700889D 00	5.4467452D 02
135.50	159	2.0750702D 00	3.8832683D 03
135.60	159	2.0939408D 00	4.0627886D 03
135.70	159	2.1013955D 00	8.3938901D 02
135.80	159	2.1049188D 00	4.7557110D 02
135.90	159	2.1227833D 00	8.7935896D 03
136.00	160	2.1100168D 00	3.3437712D 03
136.10	160	2.1145175D 00	5.2339905D 03
136.20	160	2.0913855D 00	6.8622595D 02
136.30	160	2.1182431D 00	8.4054002D 03
136.40	160	2.1132108D 00	3.6916751D 02
136.50	160	2.1233282D 00	6.5666084D 03
136.60	160	2.1223011D 00	6.1668542D 02
136.70	160	2.1257313D 00	1.0662811D 04
136.80	161	2.1148672D 00	2.9878941D 03
136.90	161	2.0983388D 00	3.9384197D 02

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
137.00	161	2.0958592D 00	1.9506334D 03
137.10	161	2.1120010D 00	2.4143213D 03
137.20	161	2.1145304D 00	1.0679219D 02
137.30	161	2.1104919D 00	2.9519489D 02
137.40	161	2.1206391D 00	4.0699821D 03
137.50	161	2.1014935D 00	8.9450934D 03
137.60	162	2.0991952D 00	4.3252909D 03
137.70	162	2.0761326D 00	4.5737175D 02
137.80	162	2.0901433D 00	8.0965018D 03
137.90	162	2.0866138D 00	9.1837418D 01
138.00	162	2.0898857D 00	3.4383623D 02
138.10	162	2.0819796D 00	1.1956551D 03
138.20	162	2.0805238D 00	6.8080521D 03
138.30	162	2.0690016D 00	7.2563350D 03
138.40	163	2.0536789D 00	5.8363903D 03
138.50	163	2.0466719D 00	1.7510308D 02
138.60	163	2.0612660D 00	8.9612256D 03
138.70	163	2.0623695D 00	4.5543989D 02
138.80	163	2.0548812D 00	5.5603930D 02
138.90	163	2.0609029D 00	6.5923172D 03
139.00	163	2.0393492D 00	8.1373064D 03
139.10	164	2.0387784D 00	4.4474398D 03
139.20	164	2.0224408D 00	1.2761281D 03
139.30	164	2.0326346D 00	8.5581439D 02
139.40	164	2.0369655D 00	2.0244283D 03
139.50	164	2.0439986D 00	3.0292124D 03
139.60	164	2.0345143D 00	6.3639735D 02
139.70	164	2.0346364D 00	1.1939210D 04
139.80	164	2.0284563D 00	9.9210135D 03
139.90	165	2.0190233D 00	4.0201666D 03
140.00	165	2.0186918D 00	1.4305883D 02
140.10	165	2.0380556D 00	7.8520079D 03
140.20	165	2.0485578D 00	3.3130211D 02
140.30	165	2.0433142D 00	2.9355757D 03
140.40	165	2.0511000D 00	1.7723756D 03
140.50	162	2.0322871D 00	1.0942730D 04
140.60	166	2.0413327D 00	1.5993702D 04
140.70	166	2.0325413D 00	4.2390705D 03
140.80	166	2.0445017D 00	1.0360464D 03
140.90	166	2.0563941D 00	1.3086855D 03
141.00	163	2.0708141D 00	2.7242143D 03
141.10	163	2.0633988D 00	1.6522154D 03
141.20	163	2.0665182D 00	6.4114906D 03
141.30	163	2.0645664D 00	9.1333612D 03
141.40	164	2.0641735D 00	1.1211220D 04
141.50	164	2.0663489D 00	3.5251738D 03
141.60	164	2.0852799D 00	1.6877652D 04
141.70	164	2.0970932D 00	5.5259292D 03
141.80	164	2.0965542D 00	6.2026701D 03
141.90	164	2.1024884D 00	1.5471997D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
142.00	164	2.0832255D 00	8.2843579D 03
142.10	165	2.0987873D 00	1.5561090D 04
142.20	165	2.0908182D 00	4.8299525D 03
142.30	165	2.0999570D 00	4.7549753D 02
142.40	165	2.1088566D 00	3.8222764D 03
142.50	165	2.1223240D 00	9.2093638D 03
142.60	165	2.1104735D 00	7.4616375D 03
142.70	165	2.1092727D 00	1.0806280D 04
142.80	165	2.1037897D 00	8.3455778D 03
142.90	166	2.1065705D 00	1.3238973D 04
143.00	166	2.1045529D 00	2.2718426D 03
143.10	166	2.1149130D 00	1.1218879D 04
143.20	166	2.1227209D 00	2.7913219D 03
143.30	166	2.1167925D 00	1.0206843D 04
143.40	166	2.1137378D 00	1.8951873D 03
143.50	166	2.0887980D 00	9.7958881D 03
143.60	166	2.1025544D 00	2.9170294D 04
143.70	167	2.0917566D 00	1.0049228D 04
143.80	167	2.0958510D 00	2.6488023D 03
143.90	167	2.0974783D 00	3.0349020D 03
144.00	167	2.1062832D 00	1.0452449D 04
144.10	167	2.0876538D 00	7.5500906D 03
144.20	167	2.0793807D 00	7.1714123D 03
144.30	167	2.0847702D 00	1.0227818D 03
144.40	167	2.0732526D 00	2.2771720D 04
144.50	167	2.0664774D 00	7.2455436D 03
144.60	168	2.0701873D 00	1.6757922D 04
144.70	168	2.0760891D 00	7.5924487D 03
144.80	168	2.0681730D 00	1.9158251D 04
144.90	168	2.0602688D 00	1.1392646D 03
145.00	168	2.0342883D 00	8.3837373D 03
145.10	168	2.0457551D 00	2.2275076D 04
145.20	168	2.0385410D 00	8.5509902D 03
145.30	168	2.0429284D 00	2.5319389D 03
145.40	169	2.0426331D 00	6.0480493D 03
145.50	169	2.0534679D 00	1.6871848D 04
145.60	169	2.0367272D 00	1.9575655D 04
145.70	169	2.0291265D 00	1.5631556D 04
145.80	169	2.0169752D 00	1.9715529D 04
145.90	169	2.0346395D 00	2.9133012D 04
146.00	169	2.0288495D 00	5.4851572D 03
146.10	169	2.0334942D 00	8.6780194D 03
146.20	170	2.0417797D 00	3.7824106D 03
146.30	170	2.0392793D 00	1.9935299D 04
146.40	170	2.0360835D 00	6.2003690D 03
146.50	170	2.0171519D 00	1.1687352D 04
146.60	170	2.0297232D 00	2.4332776D 04
146.70	170	2.0342163D 00	1.6398791D 04
146.80	170	2.0445476D 00	7.0831591D 03
146.90	170	2.0457370D 00	5.6506970D 03

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
147.00	171	2.0609340D 00	2.0124519D 04
147.10	171	2.0495160D 00	1.7170773D 04
147.20	171	2.0464079D 00	1.1901330D 04
147.30	171	2.0390685D 00	8.6165883D 03
147.40	171	2.0691968D 00	3.7420874D 04
147.50	171	2.0652072D 00	1.0218636D 04
147.60	171	2.0728922D 00	1.4314100D 04
147.70	171	2.0805446D 00	7.2158982D 03
147.80	172	2.0804179D 00	3.3106242D 04
147.90	172	2.0808814D 00	6.5426841D 03
148.00	172	2.0660175D 00	9.6913584D 03
148.10	172	2.0763478D 00	1.4780193D 04
148.20	172	2.0876363D 00	1.1312856D 04
148.30	172	2.1006703D 00	5.2866118D 03
148.40	172	2.0996065D 00	5.7119450D 03
148.50	172	2.1131703D 00	2.0848441D 04
148.60	173	2.0998417D 00	3.0380517D 04
148.70	173	2.0949921D 00	2.1412359D 04
148.80	173	2.0875308D 00	1.2941755D 04
148.90	173	2.1191448D 00	4.8878272D 04
149.00	173	2.1096998D 00	9.3907991D 03
149.10	173	2.1147433D 00	1.0326126D 04
149.20	173	2.1149529D 00	3.0815390D 03
149.30	173	2.1104327D 00	2.7292713D 04
149.40	174	2.1094150D 00	1.0696252D 04
149.50	174	2.0913507D 00	1.0140834D 04
149.60	174	2.0933406D 00	1.3010775D 04
149.70	174	2.1014737D 00	1.8289470D 04
149.80	174	2.1113740D 00	1.2634046D 04
149.90	174	2.1023975D 00	8.8012072D 03
150.00	174	2.1101377D 00	2.6170071D 04
150.10	174	2.0906551D 00	2.6182913D 04
150.20	175	2.0832364D 00	1.4562995D 04
150.30	175	2.0722434D 00	5.7844432D 03
150.40	175	2.0983419D 00	4.0844996D 04
150.50	175	2.0835960D 00	1.0057197D 04
150.60	175	2.0843248D 00	1.6579506D 04
150.70	175	2.0759713D 00	5.2766943D 03
150.80	175	2.0670998D 00	4.0076040D 04
150.90	175	2.0680122D 00	1.2010476D 04
151.00	176	2.0480051D 00	1.1078720D 04
151.10	176	2.0473515D 00	8.6307331D 03
151.20	176	2.0532236D 00	9.2605796D 03
151.30	176	2.0729498D 00	4.2911174D 04
151.40	176	2.0504221D 00	7.2457129D 03
151.50	176	2.0561619D 00	1.9955216D 04
151.60	176	2.0337648D 00	3.3743787D 04
151.70	177	2.0325080D 00	2.4081279D 04
151.80	177	2.0241783D 00	9.4242187D 03
151.90	177	2.0470580D 00	4.3119579D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
152.00	177	2.0383907D 00	1.0721940D 04
152.10	177	2.0423672D 00	1.3540790D 04
152.20	177	2.0327799D 00	2.1230025D 03
152.30	177	2.0253333D 00	2.8037793D 04
152.40	177	2.0350574D 00	8.9214913D 03
152.50	178	2.0193210D 00	9.4009581D 03
152.60	178	2.0236789D 00	6.6759272D 03
152.70	178	2.0331558D 00	1.2213033D 04
152.80	178	2.0472293D 00	2.0788552D 04
152.90	178	2.0407404D 00	1.1447169D 04
153.00	178	2.0507306D 00	2.6408720D 04
153.10	178	2.0290094D 00	2.7200222D 04
153.20	178	2.0388602D 00	1.7694686D 04
153.30	179	2.0351865D 00	3.2762819D 03
153.40	179	2.0569059D 00	2.0532004D 04
153.50	179	2.0576442D 00	6.1524686D 03
153.60	179	2.0674979D 00	1.6475506D 04
153.70	179	2.0600950D 00	3.5265755D 03
153.80	179	2.0559065D 00	3.4659352D 04
153.90	179	2.0809202D 00	5.8796369D 03
154.00	180	2.0611773D 00	8.7017796D 03
154.10	180	2.0682280D 00	5.2101427D 03
154.20	180	2.0780228D 00	4.3478957D 03
154.30	180	2.0943638D 00	1.1328989D 04
154.40	180	2.0892402D 00	6.8761694D 03
154.50	180	2.1005523D 00	1.4809938D 04
154.60	177	2.0768425D 00	2.2392700D 04
154.70	177	2.0937410D 00	3.1055948D 04
154.80	178	2.0881642D 00	6.4322794D 03
154.90	178	2.1044014D 00	2.0611289D 04
155.00	178	2.1049190D 00	8.0887665D 03
155.10	178	2.1132953D 00	1.4994171D 04
155.20	178	2.1018137D 00	8.6141827D 02
155.30	178	2.0942861D 00	1.8914042D 04
155.40	178	2.1075673D 00	4.3216404D 04
155.50	179	2.0986487D 00	8.2867203D 03
155.60	179	2.1019446D 00	3.7151952D 03
155.70	179	2.1052341D 00	5.4891632D 03
155.80	179	2.1161033D 00	1.5856452D 04
155.90	179	2.1055505D 00	1.0981879D 04
156.00	179	2.1114792D 00	1.8752921D 04
156.10	179	2.0810300D 00	1.5343558D 04
156.20	179	2.0985872D 00	2.4219930D 04
156.30	180	2.0875267D 00	1.7200109D 03
156.40	180	2.0975952D 00	8.8358141D 03
156.50	180	2.0947004D 00	6.8407952D 03
156.60	180	2.0959502D 00	1.4798268D 04
156.70	180	2.0789224D 00	2.7368919D 03
156.80	180	2.0656579D 00	1.7358189D 04
156.90	180	2.0618597D 00	3.3612498D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
157.00	180	2.0659396D 00	7.5706106D 03
157.10	181	2.0660612D 00	3.7638107D 03
157.20	181	2.0652678D 00	1.5494525D 03
157.30	181	2.0721753D 00	9.3721418D 03
157.40	181	2.0593593D 00	6.7431355D 03
157.50	181	2.0639271D 00	8.8248803D 03
157.60	181	2.0313195D 00	5.7621819D 03
157.70	181	2.0491327D 00	3.0622922D 04
157.80	181	2.0379915D 00	3.5195215D 03
157.90	182	2.0490060D 00	1.3081597D 04
158.00	182	2.0416010D 00	3.7135317D 03
158.10	182	2.0470530D 00	1.5946644D 04
158.20	182	2.0324194D 00	1.2195629D 03
158.30	182	2.0211669D 00	5.1677320D 03
158.40	182	2.0176409D 00	1.0601468D 04
158.50	182	2.0299919D 00	7.1437430D 03
158.60	182	2.0319648D 00	1.8540612D 03
158.70	183	2.0336244D 00	2.4873173D 03
158.80	183	2.0422153D 00	1.0381265D 04
158.90	183	2.0337407D 00	1.3193704D 04
159.00	183	2.0451004D 00	9.1861284D 03
159.10	183	2.0180380D 00	2.4498861D 03
159.20	183	2.0378997D 00	1.9525915D 04
159.30	183	2.0351899D 00	1.6623424D 02
159.40	183	2.0554484D 00	1.2235770D 04
159.50	183	2.0452959D 00	1.6447443D 02
159.60	184	2.0550479D 00	1.4661274D 04
159.70	184	2.0459808D 00	8.1632527D 03
159.80	184	2.0399425D 00	3.9024958D 03
159.90	184	2.0413940D 00	6.5678702D 03
160.00	184	2.0622241D 00	7.5297912D 03
160.10	184	2.0665124D 00	2.0354249D 03
160.20	184	2.0707101D 00	3.5004884D 02
160.30	184	2.0786457D 00	7.0355313D 03
160.40	185	2.0720998D 00	9.6578466D 03
160.50	185	2.0896145D 00	6.8686124D 03
160.60	185	2.0649358D 00	1.2034035D 03
160.70	185	2.0805998D 00	1.0591319D 04
160.80	185	2.0848546D 00	9.6434361D 02
160.90	185	2.1158738D 00	3.6561155D 04
161.00	185	2.0939415D 00	5.1193218D 02
161.10	185	2.1022750D 00	1.7456567D 04
161.20	186	2.0923570D 00	6.3786410D 03
161.30	186	2.0858309D 00	7.9498884D 02
161.40	186	2.0856176D 00	3.1058501D 02
161.50	186	2.1069198D 00	1.1254545D 04
161.60	186	2.1066851D 00	2.5723567D 02
161.70	186	2.1078383D 00	2.2658782D 03
161.80	186	2.1090311D 00	3.5801098D 03
161.90	186	2.0980062D 00	1.6999964D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
162.00	187	2.1183218D 00	3.9717738D 03
162.10	187	2.0857885D 00	4.7701609D 02
162.20	187	2.0932829D 00	4.1706564D 03
162.30	187	2.0957228D 00	7.1878476D 02
162.40	187	2.1052643D 00	3.0320038D 03
162.50	187	2.0944678D 00	1.3072717D 03
162.60	187	2.0978763D 00	1.1458323D 04
162.70	187	2.0828507D 00	1.5894653D 04
162.80	188	2.0747332D 00	6.7123042D 03
162.90	188	2.0702598D 00	3.8394993D 02
163.00	188	2.0889412D 00	1.6446022D 04
163.10	188	2.0807375D 00	3.2762516D 02
163.20	188	2.0776206D 00	1.0523786D 03
163.30	188	2.0716634D 00	4.2505859D 03
163.40	188	2.0571940D 00	8.7524222D 03
163.50	188	2.0815350D 00	1.2502860D 03
163.60	189	2.0451625D 00	3.9474790D 03
163.70	189	2.0494612D 00	4.2378134D 02
163.80	189	2.0507344D 00	3.1769266D 03
163.90	189	2.0582698D 00	5.7523042D 03
164.00	189	2.0452238D 00	1.4656166D 03
164.10	189	2.0480769D 00	1.3196902D 04
164.20	189	2.0313690D 00	9.7640686D 03
164.30	190	2.0292237D 00	7.7600217D 03
164.40	190	2.0263212D 00	1.7265484D 03
164.50	190	2.0491989D 00	2.4009860D 04
164.60	190	2.0397260D 00	1.2343867D 03
164.70	190	2.0387642D 00	8.5294650D 03
164.80	190	2.0316240D 00	1.5276162D 03
164.90	190	2.0197768D 00	1.2888286D 04
165.00	190	2.0396618D 00	1.6886217D 04
165.10	191	2.0200354D 00	3.2665172D 03
165.20	191	2.0283786D 00	2.0019324D 01
165.30	191	2.0339382D 00	3.3480744D 03
165.40	191	2.0467744D 00	4.2789879D 03
165.50	191	2.0371479D 00	9.4997765D 03
165.60	191	2.0444200D 00	5.0416586D 03
165.70	191	2.0288298D 00	1.4187890D 04
165.80	191	2.0407207D 00	2.4721843D 04
165.90	192	2.0379222D 00	3.6155893D 03
166.00	192	2.0664068D 00	3.3844993D 04
166.10	192	2.0588207D 00	6.5564935D 02
166.20	192	2.0630028D 00	8.4067989D 03
166.30	192	2.0575432D 00	6.2037977D 03
166.40	192	2.0493128D 00	5.5313854D 03
166.50	192	2.0654800D 00	2.2810078D 04
166.60	192	2.0594361D 00	1.2165450D 04
166.70	193	2.0698978D 00	3.5860542D 03
166.80	193	2.0759686D 00	7.9334780D 03
166.90	193	2.0907263D 00	1.1573115D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
167.00	193	2.0822252D 00	1.2873887D 04
167.10	193	2.0914890D 00	7.0330077D 03
167.20	193	2.0735446D 00	6.9308253D 03
167.30	193	2.0886571D 00	2.0805331D 04
167.40	194	2.0865161D 00	5.2207558D 03
167.50	194	2.1121219D 00	3.7958823D 04
167.60	194	2.1041817D 00	1.4319989D 04
167.70	194	2.1038279D 00	2.3306416D 04
167.80	194	2.0948878D 00	1.2367577D 04
167.90	194	2.0847865D 00	1.1758279D 04
168.00	191	2.0954001D 00	2.9017471D 04
168.10	191	2.0925272D 00	1.0518725D 04
168.20	195	2.0994203D 00	2.3038890D 03
168.30	195	2.0997012D 00	5.4139796D 03
168.40	195	2.1092213D 00	8.5610264D 03
168.50	192	2.0952710D 00	2.3966072D 04
168.60	192	2.1006649D 00	3.2538734D 03
168.70	192	2.0766800D 00	1.1896595D 04
168.80	192	2.0935227D 00	4.3439332D 04
168.90	193	2.0843155D 00	9.4165782D 03
169.00	193	2.0998549D 00	4.2742867D 04
169.10	193	2.0874497D 00	3.1649943D 03
169.20	193	2.0857160D 00	2.2251000D 04
169.30	193	2.0717112D 00	1.4732253D 04
169.40	193	2.0574548D 00	9.2647011D 03
169.50	193	2.0613641D 00	1.7227201D 04
169.60	193	2.0609014D 00	2.3053756D 04
169.70	194	2.0649580D 00	1.0045212D 04
169.80	194	2.0614263D 00	1.2793132D 04
169.90	194	2.0681505D 00	1.7274531D 04
170.00	194	2.0520360D 00	3.1561972D 04
170.10	194	2.0562293D 00	8.3229016D 03
170.20	194	2.0305754D 00	7.2129667D 03
170.30	194	2.0510167D 00	4.1461672D 04
170.40	194	2.0386286D 00	8.9983977D 03
170.50	195	2.0473881D 00	3.4168381D 04
170.60	195	2.0401148D 00	5.3023747D 03
170.70	195	2.0405151D 00	3.7090429D 04
170.80	195	2.0296901D 00	2.9180518D 04
170.90	195	2.0176608D 00	1.8691317D 04
171.00	195	2.0212238D 00	2.0122272D 04
171.10	195	2.0276176D 00	2.1193852D 04
171.20	195	2.0343732D 00	7.8350414D 03
171.30	196	2.0326535D 00	8.2356895D 03
171.40	196	2.0417981D 00	9.6707222D 03
171.50	196	2.0299720D 00	3.6423360D 04
171.60	196	2.0394915D 00	9.7586681D 03
171.70	196	2.0238869D 00	1.2155273D 04
171.80	196	2.0464536D 00	6.1718703D 04
171.90	196	2.0373490D 00	1.6173116D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
172.00	196	2.0471870D 00	3.0225810D 04
172.10	197	2.0440276D 00	4.7300584D 03
172.20	197	2.0484776D 00	3.5016955D 04
172.30	197	2.0443149D 00	2.5227542D 04
172.40	197	2.0375514D 00	1.3380498D 04
172.50	197	2.0445987D 00	1.1300599D 04
172.60	197	2.0573052D 00	3.1012145D 04
172.70	197	2.0672305D 00	1.7037169D 04
172.80	197	2.0672220D 00	2.1810393D 04
172.90	198	2.0767544D 00	1.5545751D 04
173.00	198	2.0662084D 00	4.7583595D 04
173.10	198	2.0773610D 00	2.0784489D 04
173.20	198	2.0634285D 00	1.2318926D 04
173.30	198	2.0884628D 00	4.0780385D 04
173.40	198	2.0836490D 00	1.0503390D 04
173.50	198	2.0934705D 00	2.5213338D 04
173.60	198	2.0881714D 00	8.3571754D 03
173.70	198	2.0912321D 00	4.3324500D 04
173.80	199	2.0876390D 00	4.4302390D 04
173.90	199	2.0799806D 00	2.2297527D 04
174.00	199	2.0847418D 00	1.5634181D 04
174.10	199	2.0963497D 00	2.7510819D 04
174.20	199	2.1036864D 00	1.4947158D 04
174.30	199	2.1000698D 00	1.5463175D 04
174.40	199	2.1042081D 00	6.7792334D 03
174.50	199	2.0892423D 00	4.0586120D 04
174.60	200	2.0959535D 00	2.8384445D 04
174.70	200	2.0813877D 00	1.4528713D 04
174.80	200	2.0966141D 00	3.5349185D 04
174.90	200	2.0923715D 00	1.7371736D 04
175.00	200	2.0981882D 00	3.2514566D 04
175.10	200	2.0864216D 00	9.3947315D 03
175.20	200	2.0848191D 00	4.2535329D 04
175.30	200	2.0785850D 00	3.4649253D 04
175.40	201	2.0689063D 00	1.4480846D 04
175.50	201	2.0686102D 00	7.9296118D 03
175.60	201	2.0754229D 00	2.7610628D 04
175.70	201	2.0784159D 00	1.8116270D 04
175.80	201	2.0705064D 00	2.8176782D 04
175.90	201	2.0686009D 00	8.5955441D 03
176.00	201	2.0505234D 00	5.0186984D 04
176.10	201	2.0572262D 00	4.2662822D 04
176.20	202	2.0436340D 00	9.8172045D 03
176.30	202	2.0526683D 00	1.8357341D 04
176.40	202	2.0495628D 00	7.3913609D 03
176.50	202	2.0545928D 00	2.4684185D 04
176.60	202	2.0401556D 00	1.1169100D 04
176.70	202	2.0375193D 00	4.1174896D 04
176.80	202	2.0315870D 00	4.7247517D 04
176.90	203	2.0278270D 00	2.4046326D 04

BACK SCATTER INTENSITY FUNCTIONS

ALPHA	NO. OF TERMS	QS	I(180)
177.00	203	2.0285176D 00	1.3182197D 04
177.10	203	2.0360954D 00	2.3648567D 04
177.20	203	2.0410066D 00	1.7601009D 04
177.30	203	2.0347276D 00	1.9585567D 04
177.40	203	2.0322300D 00	2.5761076D 03
177.50	203	2.0169346D 00	3.0985295D 04
177.60	203	2.0305528D 00	4.7723317D 04
177.70	204	2.0217457D 00	1.1789145D 04
177.80	204	2.0330724D 00	1.4992304D 04
177.90	204	2.0350037D 00	1.1545569D 04
178.00	204	2.0450217D 00	3.5023697D 04
178.10	204	2.0337235D 00	1.2135745D 04
178.20	204	2.0344396D 00	4.1403205D 04
178.30	204	2.0309349D 00	2.9466080D 04
178.40	204	2.0364347D 00	1.6022367D 04
178.50	205	2.0406227D 00	5.9959046D 03
178.60	205	2.0511710D 00	1.8309815D 04
178.70	205	2.0598949D 00	1.8348846D 04
178.80	205	2.0582182D 00	2.8217905D 04
178.90	205	2.0569709D 00	1.6797357D 03
179.00	205	2.0458416D 00	3.4384171D 04
179.10	205	2.0652949D 00	5.8623630D 04
179.20	205	2.0589906D 00	8.2759514D 03
179.30	206	2.0711624D 00	9.9215615D 03
179.40	206	2.0740641D 00	3.5351071D 03
179.50	206	2.0863670D 00	2.2274320D 04
179.60	206	2.0761519D 00	1.0671494D 04
179.70	206	2.0770082D 00	2.8473867D 04
179.80	206	2.0728447D 00	2.3621418D 04
179.90	206	2.0839249D 00	2.6613932D 04
180.00	207	2.0854432D 00	1.1449501D 04
180.10	207	2.0925745D 00	1.5876509D 04
180.20	207	2.0977616D 00	1.4540698D 04
180.30	207	2.0954409D 00	2.0470935D 04
180.40	207	2.0907221D 00	3.1940566D 02
180.50	207	2.0783336D 00	1.3159096D 04
180.60	207	2.0956633D 00	4.3682436D 04
180.70	207	2.0888566D 00	7.4722746D 03
180.80	208	2.0968820D 00	9.6225968D 03
180.90	208	2.0937563D 00	6.0619046D 03
181.00	208	2.1016896D 00	3.3071366D 04
181.10	208	2.0873408D 00	1.2824158D 04
181.20	208	2.0829268D 00	2.5612750D 04
181.30	208	2.0753357D 00	6.7654129D 03
181.40	205	2.0867789D 00	1.6441540D 04
181.50	205	2.0823839D 00	3.9342228D 03
181.60	209	2.0840289D 00	9.6499830D 03
181.70	209	2.0825507D 00	5.8621500D 03
181.80	209	2.0765258D 00	2.8034201D 04
181.90	206	2.0678371D 00	1.5620947D 03

APPENDIX III

Values of Φ and K are tabulated in this appendix for various laser wavelengths, atmospheric radii limits, incremental size parameters, and values of size distribution parameter.

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.10	181.00	0.0392	10.0018	1.2050086D 00	3.9517535D 00	0.3472	2.50
0.46	0.10	118.60	0.0388	10.0042	1.1776678D 00	3.8925297D 00	0.5300	2.50
0.38	0.10	96.70	0.0393	10.0037	1.1613799D 00	3.8530196D 00	0.6500	2.50
0.35	0.10	90.50	0.0387	10.0004	1.1562599D 00	3.8388696D 00	0.6943	2.50
0.23	0.10	59.30	0.0388	10.0042	1.1178723D 00	3.7349920D 00	1.0600	2.50
0.71	0.10	181.00	0.0392	10.0018	4.3969632D-01	1.8360648D 00	0.3472	3.00
0.46	0.10	118.60	0.0388	10.0042	4.4841787D-01	1.8471357D 00	0.5300	3.00
0.38	0.10	96.70	0.0393	10.0037	4.4861218D-01	1.8458998D 00	0.6500	3.00
0.35	0.10	90.50	0.0387	10.0004	4.4853833D-01	1.8450114D 00	0.6943	3.00
0.23	0.10	59.30	0.0388	10.0042	4.4488736D-01	1.8349721D 00	1.0600	3.00
0.71	0.10	181.00	0.0392	10.0018	2.1018283D-01	1.0354543D 00	0.3472	3.50
0.46	0.10	118.60	0.0388	10.0042	2.2539814D-01	1.0578136D 00	0.5300	3.50
0.38	0.10	96.70	0.0393	10.0037	2.2830110D-01	1.0618310D 00	0.6500	3.50
0.35	0.10	90.50	0.0387	10.0004	2.2912987D-01	1.0628771D 00	0.6943	3.50
0.23	0.10	59.30	0.0388	10.0042	2.3086882D-01	1.0656455D 00	1.0600	3.50
0.71	0.10	181.00	0.0392	10.0018	1.2809336D-01	6.6097566D-01	0.3472	4.00
0.46	0.10	118.60	0.0388	10.0042	1.4874139D-01	6.9192222D-01	0.5300	4.00
0.38	0.10	96.70	0.0393	10.0037	1.5369137D-01	6.9898386D-01	0.6500	4.00
0.35	0.10	90.50	0.0387	10.0004	1.5527606D-01	7.0117691D-01	0.6943	4.00
0.23	0.10	59.30	0.0388	10.0042	1.6011098D-01	7.0872590D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.20	181.00	0.0392	10.0018	1.2212501D 00	3.9890835D 00	0.3472	2.50
0.46	0.20	118.60	0.0388	10.0042	1.1912092D 00	3.9259061D 00	0.5300	2.50
0.38	0.20	96.70	0.0393	10.0037	1.1566286D 00	3.8844318D 00	0.6500	2.50
0.35	0.20	90.50	0.0387	10.0004	1.1512932D 00	3.8698523D 00	0.6943	2.50
0.23	0.20	59.30	0.0388	10.0042	1.1098919D 00	3.7663063D 00	1.0600	2.50
0.71	0.20	181.00	0.0392	10.0018	4.4808101D-01	1.8633762D 00	0.3472	3.00
0.46	0.20	118.60	0.0388	10.0042	4.5446332D-01	1.8711558D 00	0.5300	3.00
0.38	0.20	96.70	0.0393	10.0037	4.4994895D-01	1.8677242D 00	0.6500	3.00
0.35	0.20	90.50	0.0387	10.0004	4.4961251D-01	1.8664480D 00	0.6943	3.00
0.23	0.20	59.30	0.0388	10.0042	4.4448701D-01	1.8579103D 00	1.0600	3.00
0.71	0.20	181.00	0.0392	10.0018	2.1664079D-01	1.0566382D 00	0.3472	3.50
0.46	0.20	118.60	0.0388	10.0042	2.2980591D-01	1.0760934D 00	0.5300	3.50
0.38	0.20	96.70	0.0393	10.0037	2.3110269D-01	1.0776645D 00	0.6500	3.50
0.35	0.20	90.50	0.0387	10.0004	2.3164977D-01	1.0783179D 00	0.6943	3.50
0.23	0.20	59.30	0.0388	10.0042	2.3219517D-01	1.0826225D 00	1.0600	3.50
0.71	0.20	181.00	0.0392	10.0018	1.3432098D-01	6.7869851D-01	0.3472	4.00
0.46	0.20	118.60	0.0388	10.0042	1.5339691D-01	7.0724034D-01	0.5300	4.00
0.38	0.20	96.70	0.0393	10.0037	1.5751476D-01	7.1184466D-01	0.6500	4.00
0.35	0.20	90.50	0.0387	10.0004	1.5881503D-01	7.1363872D-01	0.6943	4.00
0.23	0.20	59.30	0.0388	10.0042	1.6247111D-01	7.2228490D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.50	181.00	0.0392	10.0018	1.1696409D 00	4.0909051D 00	0.3472	2.50
0.46	0.50	118.60	0.0388	10.0042	1.1344452D 00	4.0202560D 00	0.5300	2.50
0.38	0.50	96.70	0.0393	10.0037	1.2225358D 00	3.9828109D 00	0.6500	2.50
0.35	0.50	90.50	0.0387	10.0004	1.2164053D 00	3.9668428D 00	0.6943	2.50
0.23	0.50	59.30	0.0388	10.0042	1.0770893D 00	3.8625061D 00	1.0600	2.50
0.71	0.50	181.00	0.0392	10.0018	4.4375647D-01	1.9377568D 00	0.3472	3.00
0.46	0.50	118.60	0.0388	10.0042	4.4140084D-01	1.9319207D 00	0.5300	3.00
0.38	0.50	96.70	0.0393	10.0037	4.7130572D-01	1.9301674D 00	0.6500	3.00
0.35	0.50	90.50	0.0387	10.0004	4.6973709D-01	1.9274752D 00	0.6943	3.00
0.23	0.50	59.30	0.0388	10.0042	4.3856877D-01	1.9209577D 00	1.0600	3.00
0.71	0.50	181.00	0.0392	10.0018	2.2589761D-01	1.1142903D 00	0.3472	3.50
0.46	0.50	118.60	0.0388	10.0042	2.3115557D-01	1.1173249D 00	0.5300	3.50
0.38	0.50	96.70	0.0393	10.0037	2.4180998D-01	1.1198887D 00	0.6500	3.50
0.35	0.50	90.50	0.0387	10.0004	2.4113978D-01	1.1192289D 00	0.6943	3.50
0.23	0.50	59.30	0.0388	10.0042	2.3396828D-01	1.1248504D 00	1.0600	3.50
0.71	0.50	181.00	0.0392	10.0018	1.4913114D-01	7.2742539D-01	0.3472	4.00
0.46	0.50	118.60	0.0388	10.0042	1.6170233D-01	7.3973036D-01	0.5300	4.00
0.38	0.50	96.70	0.0393	10.0037	1.6786285D-01	7.4482021D-01	0.6500	4.00
0.35	0.50	90.50	0.0387	10.0004	1.6798852D-01	7.4533805D-01	0.6943	4.00
0.23	0.50	59.30	0.0388	10.0042	1.6790379D-01	7.5334670D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.10	181.00	0.0597	10.0018	1.1772923D 00	3.8947342D 00	0.3472	2.50
0.70	0.10	118.60	0.0590	10.0042	1.1690037D 00	3.8800986D 00	0.5300	2.50
0.57	0.10	96.70	0.0590	10.0037	1.1575231D 00	3.8473292D 00	0.6500	2.50
0.53	0.10	90.50	0.0586	10.0004	1.1525435D 00	3.8345142D 00	0.6943	2.50
0.35	0.10	59.30	0.0590	10.0042	1.1179560D 00	3.7341384D 00	1.0600	2.50
1.08	0.10	181.00	0.0597	10.0018	4.0951540D-01	1.7744343D 00	0.3472	3.00
0.70	0.10	118.60	0.0590	10.0042	4.3728446D-01	1.8310524D 00	0.5300	3.00
0.57	0.10	96.70	0.0590	10.0037	4.4282786D-01	1.8373986D 00	0.6500	3.00
0.53	0.10	90.50	0.0586	10.0004	4.4340288D-01	1.8387570D 00	0.6943	3.00
0.35	0.10	59.30	0.0590	10.0042	4.4406137D-01	1.8327004D 00	1.0600	3.00
1.08	0.10	181.00	0.0597	10.0018	1.7735741D-01	9.6905835D-01	0.3472	3.50
0.70	0.10	118.60	0.0590	10.0042	2.1068965D-01	1.0361995D 00	0.5300	3.50
0.57	0.10	96.70	0.0590	10.0037	2.1959379D-01	1.0490628D 00	0.6500	3.50
0.53	0.10	90.50	0.0586	10.0004	2.2149152D-01	1.0529758D 00	0.6943	3.50
0.35	0.10	59.30	0.0590	10.0042	2.2860519D-01	1.0614246D 00	1.0600	3.50
1.08	0.10	181.00	0.0597	10.0018	9.2364745D-02	5.8942836D-01	0.3472	4.00
0.70	0.10	118.60	0.0590	10.0042	1.2900438D-01	6.6247073D-01	0.5300	4.00
0.57	0.10	96.70	0.0590	10.0037	1.4054017D-01	6.7972868D-01	0.6500	4.00
0.53	0.10	90.50	0.0586	10.0004	1.4350657D-01	6.8520016D-01	0.6943	4.00
0.35	0.10	59.30	0.0590	10.0042	1.5521440D-01	7.0100491D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.20	181.00	0.0597	10.0018	1.1949101D 00	3.9388245D 00	0.3472	2.50
0.70	0.20	118.60	0.0590	10.0042	1.1849925D 00	3.9171024D 00	0.5300	2.50
0.57	0.20	96.70	0.0590	10.0037	1.1537343D 00	3.8802630D 00	0.6500	2.50
0.53	0.20	90.50	0.0586	10.0004	1.1675234D 00	3.8697683D 00	0.6943	2.50
0.35	0.20	59.30	0.0590	10.0042	1.1117238D 00	3.7648959D 00	1.0600	2.50
1.08	0.20	181.00	0.0597	10.0018	4.1890597D-01	1.8080785D 00	0.3472	3.00
0.70	0.20	118.60	0.0590	10.0042	4.4556230D-01	1.8581406D 00	0.5300	3.00
0.57	0.20	96.70	0.0590	10.0037	4.4533178D-01	1.8611113D 00	0.6500	3.00
0.53	0.20	90.50	0.0586	10.0004	4.5054159D-01	1.8637532D 00	0.6943	3.00
0.35	0.20	59.30	0.0590	10.0042	4.4496596D-01	1.8541018D 00	1.0600	3.00
1.08	0.20	181.00	0.0597	10.0018	1.8422054D-01	9.9555158D-01	0.3472	3.50
0.70	0.20	118.60	0.0590	10.0042	2.1707209D-01	1.0572028D 00	0.5300	3.50
0.57	0.20	96.70	0.0590	10.0037	2.2369382D-01	1.0670717D 00	0.6500	3.50
0.53	0.20	90.50	0.0586	10.0004	2.2680594D-01	1.0718452D 00	0.6943	3.50
0.35	0.20	59.30	0.0590	10.0042	2.3110254D-01	1.0768602D 00	1.0600	3.50
1.08	0.20	181.00	0.0597	10.0018	9.8175765D-02	6.1095958D-01	0.3472	4.00
0.70	0.20	118.60	0.0590	10.0042	1.3518414D-01	6.8005630D-01	0.5300	4.00
0.57	0.20	96.70	0.0590	10.0037	1.4559677D-01	6.9480929D-01	0.6500	4.00
0.53	0.20	90.50	0.0586	10.0004	1.4888462D-01	7.0088724D-01	0.6943	4.00
0.35	0.20	59.30	0.0590	10.0042	1.5875039D-01	7.1346598D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.50	181.00	0.0597	10.0018	1.2749096D 00	4.0684598D 00	0.3472	2.50
0.70	0.50	118.60	0.0590	10.0042	1.1372513D 00	4.0174338D 00	0.5300	2.50
0.57	0.50	96.70	0.0590	10.0037	1.2360321D 00	3.9856393D 00	0.6500	2.50
0.53	0.50	90.50	0.0586	10.0004	1.1110347D 00	3.9621953D 00	0.6943	2.50
0.35	0.50	59.30	0.0590	10.0042	1.1789526D 00	3.8604246D 00	1.0600	2.50
1.08	0.50	181.00	0.0597	10.0018	4.5719470D-01	1.9060595D 00	0.3472	3.00
0.70	0.50	118.60	0.0590	10.0042	4.4131787D-01	1.9314607D 00	0.5300	3.00
0.57	0.50	96.70	0.0590	10.0037	4.7809721D-01	1.9364486D 00	0.6500	3.00
0.53	0.50	90.50	0.0586	10.0004	4.3890872D-01	1.9360732D 00	0.6943	3.00
0.35	0.50	59.30	0.0590	10.0042	4.6536745D-01	1.9149390D 00	1.0600	3.00
1.08	0.50	181.00	0.0597	10.0018	2.0890105D-01	1.0727375D 00	0.3472	3.50
0.70	0.50	118.60	0.0590	10.0042	2.2611459D-01	1.1140044D 00	0.5300	3.50
0.57	0.50	96.70	0.0590	10.0037	2.4239108D-01	1.1247740D 00	0.6500	3.50
0.53	0.50	90.50	0.0586	10.0004	2.3026778D-01	1.1297845D 00	0.6943	3.50
0.35	0.50	59.30	0.0590	10.0042	2.4062871D-01	1.1177466D 00	1.0600	3.50
1.08	0.50	181.00	0.0597	10.0018	1.1787197D-01	6.7429318D-01	0.3472	4.00
0.70	0.50	118.60	0.0590	10.0042	1.4981136D-01	7.2812899D-01	0.5300	4.00
0.57	0.50	96.70	0.0590	10.0037	1.6207960D-01	7.4350701D-01	0.6500	4.00
0.53	0.50	90.50	0.0586	10.0004	1.5943374D-01	7.5075985D-01	0.6943	4.00
0.35	0.50	59.30	0.0590	10.0042	1.6792860D-01	7.4516210D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.10	181.00	0.0796	10.0018	1.1468031D 00	3.7840695D 00	0.3472	2.50
0.94	0.10	118.60	0.0793	10.0042	1.1534379D 00	3.8502472D 00	0.5300	2.50
0.76	0.10	96.70	0.0786	10.0037	1.1490127D 00	3.8334817D 00	0.6500	2.50
0.71	0.10	90.50	0.0785	10.0004	1.1456618D 00	3.8236441D 00	0.6943	2.50
0.46	0.10	59.30	0.0776	10.0042	1.1165251D 00	3.7321554D 00	1.0600	2.50
1.44	0.10	181.00	0.0796	10.0018	3.8170589D-01	1.6745790D 00	0.3472	3.00
0.94	0.10	118.60	0.0793	10.0042	4.1934908D-01	1.7969013D 00	0.5300	3.00
0.76	0.10	96.70	0.0786	10.0037	4.3211105D-01	1.8200030D 00	0.6500	3.00
0.71	0.10	90.50	0.0785	10.0004	4.3440346D-01	1.8245639D 00	0.6943	3.00
0.46	0.10	59.30	0.0776	10.0042	4.4167810D-01	1.8293449D 00	1.0600	3.00
1.44	0.10	181.00	0.0796	10.0018	1.5195134D-01	8.7879873D-01	0.3472	3.50
0.94	0.10	118.60	0.0793	10.0042	1.9018262D-01	9.9754181D-01	0.5300	3.50
0.76	0.10	96.70	0.0786	10.0037	2.0607614D-01	1.0271601D 00	0.6500	3.50
0.71	0.10	90.50	0.0785	10.0004	2.0970588D-01	1.0344117D 00	0.6943	3.50
0.46	0.10	59.30	0.0776	10.0042	2.2464903D-01	1.0558207D 00	1.0600	3.50
1.44	0.10	181.00	0.0796	10.0018	6.9116778D-02	5.0769817D-01	0.3472	4.00
0.94	0.10	118.60	0.0793	10.0042	1.0563904D-01	6.1886311D-01	0.5300	4.00
0.76	0.10	96.70	0.0786	10.0037	1.2346270D-01	6.5209790D-01	0.6500	4.00
0.71	0.10	90.50	0.0785	10.0004	1.2804994D-01	6.6088024D-01	0.6943	4.00
0.46	0.10	59.30	0.0776	10.0042	1.4865745D-01	6.9169684D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.20	181.00	0.0796	10.0018	1.1624797D 00	3.8345863D 00	0.3472	2.50
0.94	0.20	118.60	0.0793	10.0042	1.1522345D 00	3.8893292D 00	0.5300	2.50
0.76	0.20	96.70	0.0786	10.0037	1.1465759D 00	3.8690351D 00	0.6500	2.50
0.71	0.20	90.50	0.0785	10.0004	1.1618633D 00	3.8610592D 00	0.6943	2.50
0.46	0.20	59.30	0.0776	10.0042	1.1310640D 00	3.7657035D 00	1.0600	2.50
1.44	0.20	181.00	0.0796	10.0018	3.8878127D-01	1.7121399D 00	0.3472	3.00
0.94	0.20	118.60	0.0793	10.0042	4.2407263D-01	1.8262523D 00	0.5300	3.00
0.76	0.20	96.70	0.0786	10.0037	4.3592497D-01	1.8463902D 00	0.6500	3.00
0.71	0.20	90.50	0.0785	10.0004	4.4278453D-01	1.8518816D 00	0.6943	3.00
0.46	0.20	59.30	0.0776	10.0042	4.4785527D-01	1.8533812D 00	1.0600	3.00
1.44	0.20	181.00	0.0796	10.0018	1.5620714D-01	9.0710864D-01	0.3472	3.50
0.94	0.20	118.60	0.0793	10.0042	1.9595856D-01	1.0205090D 00	0.5300	3.50
0.76	0.20	96.70	0.0786	10.0037	2.1131318D-01	1.0477140D 00	0.6500	3.50
0.71	0.20	90.50	0.0785	10.0004	2.1616357D-01	1.0555960D 00	0.6943	3.50
0.46	0.20	59.30	0.0776	10.0042	2.2907411D-01	1.0741019D 00	1.0600	3.50
1.44	0.20	181.00	0.0796	10.0018	7.2094487D-02	5.2929187D-01	0.3472	4.00
0.94	0.20	118.60	0.0793	10.0042	1.1153510D-01	6.3777865D-01	0.5300	4.00
0.76	0.20	96.70	0.0786	10.0037	1.2928893D-01	6.6931641D-01	0.6500	4.00
0.71	0.20	90.50	0.0785	10.0004	1.3427755D-01	6.7860312D-01	0.6943	4.00
0.46	0.20	59.30	0.0776	10.0042	1.5331524D-01	7.0701511D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.50	181.00	0.0796	10.0018	1.1205867D 00	3.9807360D 00	0.3472	2.50
0.94	0.50	118.60	0.0793	10.0042	1.1227097D 00	4.0045617D 00	0.5300	2.50
0.76	0.50	96.70	0.0786	10.0037	1.1749816D 00	3.9706202D 00	0.6500	2.50
0.71	0.50	90.50	0.0785	10.0004	1.1155559D 00	3.9624590D 00	0.6943	2.50
0.46	0.50	59.30	0.0776	10.0042	1.0707987D 00	3.8587554D 00	1.0600	2.50
1.44	0.50	181.00	0.0796	10.0018	3.8243719D-01	1.8156327D 00	0.3472	3.00
0.94	0.50	118.60	0.0793	10.0042	4.2478771D-01	1.9086581D 00	0.5300	3.00
0.76	0.50	96.70	0.0786	10.0037	4.5776578D-01	1.9201194D 00	0.6500	3.00
0.71	0.50	90.50	0.0785	10.0004	4.3892182D-01	1.9262110D 00	0.6943	3.00
0.46	0.50	59.30	0.0776	10.0042	4.3437595D-01	1.9139783D 00	1.0600	3.00
1.44	0.50	181.00	0.0796	10.0018	1.6030485D-01	9.8166743D-01	0.3472	3.50
0.94	0.50	118.60	0.0793	10.0042	2.0708812D-01	1.0828076D 00	0.5300	3.50
0.76	0.50	96.70	0.0786	10.0037	2.2948680D-01	1.1045290D 00	0.6500	3.50
0.71	0.50	90.50	0.0785	10.0004	2.2546111D-01	1.1132422D 00	0.6943	3.50
0.46	0.50	59.30	0.0776	10.0042	2.3037414D-01	1.1153118D 00	1.0600	3.50
1.44	0.50	181.00	0.0796	10.0018	7.8213333D-02	5.8433648D-01	0.3472	4.00
0.94	0.50	118.60	0.0793	10.0042	1.2648959D-01	6.8857934D-01	0.5300	4.00
0.76	0.50	96.70	0.0786	10.0037	1.4711164D-01	7.1725219D-01	0.6500	4.00
0.71	0.50	90.50	0.0785	10.0004	1.4909135D-01	7.2732934D-01	0.6943	4.00
0.46	0.50	59.30	0.0776	10.0042	1.6161473D-01	7.3950231D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.10	54.30	0.0392	3.0005	1.0948952D 00	3.6939711D 00	0.3472	2.50
0.46	0.10	35.60	0.0388	3.0029	1.0500875D 00	3.5691579D 00	0.5300	2.50
0.38	0.10	29.00	0.0393	3.0001	1.0058349D 00	3.4908546D 00	0.6500	2.50
0.35	0.10	27.10	0.0387	2.9946	9.8956483D-01	3.4631848D 00	0.6943	2.50
0.23	0.10	17.80	0.0388	3.0029	8.9531258D-01	3.2633847D 00	1.0600	2.50
0.71	0.10	54.30	0.0392	3.0005	4.2827067D-01	1.8089396D 00	0.3472	3.00
0.46	0.10	35.60	0.0388	3.0029	4.3202001D-01	1.8050769D 00	0.5300	3.00
0.38	0.10	29.00	0.0393	3.0001	4.2587825D-01	1.7936761D 00	0.6500	3.00
0.35	0.10	27.10	0.0387	2.9946	4.2323520D-01	1.7890080D 00	0.6943	3.00
0.23	0.10	17.80	0.0388	3.0029	4.0423337D-01	1.7481963D 00	1.0600	3.00
0.71	0.10	54.30	0.0392	3.0005	2.0896117D-01	1.0325190D 00	0.3472	3.50
0.46	0.10	35.60	0.0388	3.0029	2.2323800D-01	1.0521881D 00	0.5300	3.50
0.38	0.10	29.00	0.0393	3.0001	2.2488248D-01	1.0540862D 00	0.6500	3.50
0.35	0.10	27.10	0.0387	2.9946	2.2517793D-01	1.0542917D 00	0.6943	3.50
0.23	0.10	17.80	0.0388	3.0029	2.2325278D-01	1.0492279D 00	1.0600	3.50
0.71	0.10	54.30	0.0392	3.0005	1.2795904D-01	6.6064975D-01	0.3472	4.00
0.46	0.10	35.60	0.0388	3.0029	1.4845024D-01	6.9115021D-01	0.5300	4.00
0.38	0.10	29.00	0.0393	3.0001	1.5316371D-01	6.9780539D-01	0.6500	4.00
0.35	0.10	27.10	0.0387	2.9946	1.5464265D-01	6.9982656D-01	0.6943	4.00
0.23	0.10	17.80	0.0388	3.0029	1.5865133D-01	7.0553938D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.20	54.30	0.0392	3.0005	1.1108388D 00	3.7313878D 00	0.3472	2.50
0.46	0.20	35.60	0.0388	3.0029	1.0609872D 00	3.6015804D 00	0.5300	2.50
0.38	0.20	29.00	0.0393	3.0001	1.0054258D 00	3.5225505D 00	0.6500	2.50
0.35	0.20	27.10	0.0387	2.9946	9.8982183D-01	3.4931678D 00	0.6943	2.50
0.23	0.20	17.80	0.0388	3.0029	8.8757476D-01	3.2951061D 00	1.0600	2.50
0.71	0.20	54.30	0.0392	3.0005	4.3662049D-01	1.8362577D 00	0.3472	3.00
0.46	0.20	35.60	0.0388	3.0029	4.3769533D-01	1.8289253D 00	0.5300	3.00
0.38	0.20	29.00	0.0393	3.0001	4.2788344D-01	1.8155330D 00	0.6500	3.00
0.35	0.20	27.10	0.0387	2.9946	4.2514486D-01	1.8102290D 00	0.6943	3.00
0.23	0.20	17.80	0.0388	3.0029	4.0348288D-01	1.7711752D 00	1.0600	3.00
0.71	0.20	54.30	0.0392	3.0005	2.1541494D-01	1.0537034D 00	0.3472	3.50
0.46	0.20	35.60	0.0388	3.0029	2.2759385D-01	1.0704380D 00	0.5300	3.50
0.38	0.20	29.00	0.0393	3.0001	2.2778913D-01	1.0699236D 00	0.6500	3.50
0.35	0.20	27.10	0.0387	2.9946	2.2783414D-01	1.0696883D 00	0.6943	3.50
0.23	0.20	17.80	0.0388	3.0029	2.2444286D-01	1.0662072D 00	1.0600	3.50
0.71	0.20	54.30	0.0392	3.0005	1.3418615D-01	6.7837264D-01	0.3472	4.00
0.46	0.20	35.60	0.0388	3.0029	1.5309847D-01	7.0646323D-01	0.5300	4.00
0.38	0.20	29.00	0.0393	3.0001	1.5700394D-01	7.1066667D-01	0.6500	4.00
0.35	0.20	27.10	0.0387	2.9946	1.5820426D-01	7.1227959D-01	0.6943	4.00
0.23	0.20	17.80	0.0388	3.0029	1.6097256D-01	7.1909791D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.50	54.30	0.0392	3.0005	1.0647681D 00	3.8330729D 00	0.3472	2.50
0.46	0.50	35.60	0.0388	3.0029	9.8864335D-01	3.6951272D 00	0.5300	2.50
0.38	0.50	29.00	0.0393	3.0001	1.0757501D 00	3.6200712D 00	0.6500	2.50
0.35	0.50	27.10	0.0387	2.9946	1.0492544D 00	3.5888923D 00	0.6943	2.50
0.23	0.50	17.80	0.0388	3.0029	8.5583594D-01	3.3871156D 00	1.0600	2.50
0.71	0.50	54.30	0.0392	3.0005	4.3286046D-01	1.9106044D 00	0.3472	3.00
0.46	0.50	35.60	0.0388	3.0029	4.2241463D-01	1.8895667D 00	0.5300	3.00
0.38	0.50	29.00	0.0393	3.0001	4.4947662D-01	1.8777622D 00	0.6500	3.00
0.35	0.50	27.10	0.0387	2.9946	4.4364670D-01	1.8709947D 00	0.6943	3.00
0.23	0.50	17.80	0.0388	3.0029	3.9795610D-01	1.8332856D 00	1.0600	3.00
0.71	0.50	54.30	0.0392	3.0005	2.2473441D-01	1.1113497D 00	0.3472	3.50
0.46	0.50	35.60	0.0388	3.0029	2.2862456D-01	1.1116504D 00	0.5300	3.50
0.38	0.50	29.00	0.0393	3.0001	2.3846513D-01	1.1121018D 00	0.6500	3.50
0.35	0.50	27.10	0.0387	2.9946	2.3694525D-01	1.1105466D 00	0.6943	3.50
0.23	0.50	17.80	0.0388	3.0029	2.2635610D-01	1.1082234D 00	1.0600	3.50
0.71	0.50	54.30	0.0392	3.0005	1.4900381D-01	7.2709863D-01	0.3472	4.00
0.46	0.50	35.60	0.0388	3.0029	1.6135760D-01	7.3895028D-01	0.5300	4.00
0.38	0.50	29.00	0.0393	3.0001	1.6733661D-01	7.4363294D-01	0.6500	4.00
0.35	0.50	27.10	0.0387	2.9946	1.6729677D-01	7.4396839D-01	0.6943	4.00
0.23	0.50	17.80	0.0388	3.0029	1.6644974D-01	7.5011143D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.10	90.50	0.0392	5.0009	1.1456618D 00	3.8236441D 00	0.3472	2.50
0.46	0.10	59.30	0.0388	5.0021	1.1165251D 00	3.7321554D 00	0.5300	2.50
0.38	0.10	48.30	0.0393	4.9967	1.0843249D 00	3.6739235D 00	0.6500	2.50
0.35	0.10	45.20	0.0387	4.9947	1.0725287D 00	3.6535654D 00	0.6943	2.50
0.23	0.10	29.60	0.0388	4.9936	1.0114021D 00	3.5009453D 00	1.0600	2.50
0.71	0.10	90.50	0.0392	5.0009	4.3440346D-01	1.8245639D 00	0.3472	3.00
0.46	0.10	59.30	0.0388	5.0021	4.4167810D-01	1.8293449D 00	0.5300	3.00
0.38	0.10	48.30	0.0393	4.9967	4.3900324D-01	1.8238874D 00	0.6500	3.00
0.35	0.10	45.20	0.0387	4.9947	4.3772527D-01	1.8214753D 00	0.6943	3.00
0.23	0.10	29.60	0.0388	4.9936	4.2818229D-01	1.7982114D 00	1.0600	3.00
0.71	0.10	90.50	0.0392	5.0009	2.0970588D-01	1.0344117D 00	0.3472	3.50
0.46	0.10	59.30	0.0388	5.0021	2.2464903D-01	1.0558207D 00	0.5300	3.50
0.38	0.10	48.30	0.0393	4.9967	2.2709089D-01	1.0590988D 00	0.6500	3.50
0.35	0.10	45.20	0.0387	4.9947	2.2772022D-01	1.0598584D 00	0.6943	3.50
0.23	0.10	29.60	0.0388	4.9936	2.2821644D-01	1.0598146D 00	1.0600	3.50
0.71	0.10	90.50	0.0392	5.0009	1.2804994D-01	6.6088024D-01	0.3472	4.00
0.46	0.10	59.30	0.0388	5.0021	1.4865745D-01	6.9169684D-01	0.5300	4.00
0.38	0.10	48.30	0.0393	4.9967	1.5353749D-01	6.9864152D-01	0.6500	4.00
0.35	0.10	45.20	0.0387	4.9947	1.5509063D-01	7.0078606D-01	0.6943	4.00
0.23	0.10	29.60	0.0388	4.9936	1.5968496D-01	7.0779218D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.20	90.50	0.0392	5.0009	1.1618633D 00	3.8610592D 00	0.3472	2.50
0.46	0.20	59.30	0.0388	5.0021	1.1310640D 00	3.7657035D 00	0.5300	2.50
0.38	0.20	48.30	0.0393	4.9967	1.0804898D 00	3.7048900D 00	0.6500	2.50
0.35	0.20	45.20	0.0387	4.9947	1.0698929D 00	3.6847851D 00	0.6943	2.50
0.23	0.20	29.60	0.0388	4.9936	1.0106227D 00	3.5328722D 00	1.0600	2.50
0.71	0.20	90.50	0.0392	5.0009	4.4278453D-01	1.8518816D 00	0.3472	3.00
0.46	0.20	59.30	0.0388	5.0021	4.4785527D-01	1.8533812D 00	0.5300	3.00
0.38	0.20	48.30	0.0393	4.9967	4.4045717D-01	1.8456383D 00	0.6500	3.00
0.35	0.20	45.20	0.0387	4.9947	4.3912081D-01	1.8429367D 00	0.6943	3.00
0.23	0.20	29.60	0.0388	4.9936	4.2891856D-01	1.8212358D 00	1.0600	3.00
0.71	0.20	90.50	0.0392	5.0009	2.1616357D-01	1.0555960D 00	0.3472	3.50
0.46	0.20	59.30	0.0388	5.0021	2.2907411D-01	1.0741019D 00	0.5300	3.50
0.38	0.20	48.30	0.0393	4.9967	2.2990764D-01	1.0749208D 00	0.6500	3.50
0.35	0.20	45.20	0.0387	4.9947	2.3028465D-01	1.0753018D 00	0.6943	3.50
0.23	0.20	29.60	0.0388	4.9936	2.2972600D-01	1.0768041D 00	1.0600	3.50
0.71	0.20	90.50	0.0392	5.0009	1.3427755D-01	6.7860312D-01	0.3472	4.00
0.46	0.20	59.30	0.0388	5.0021	1.5331524D-01	7.0701511D-01	0.5300	4.00
0.38	0.20	48.30	0.0393	4.9967	1.5736286D-01	7.1150056D-01	0.6500	4.00
0.35	0.20	45.20	0.0387	4.9947	1.5863579D-01	7.1324814D-01	0.6943	4.00
0.23	0.20	29.60	0.0388	4.9936	1.6207521D-01	7.2135299D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
0.71	0.50	90.50	0.0392	5.0009	1.1155559D 00	3.9624590D 00	0.3472	2.50
0.46	0.50	59.30	0.0388	5.0021	1.0707987D 00	3.8587554D 00	0.5300	2.50
0.38	0.50	48.30	0.0393	4.9967	1.1579550D 00	3.8019279D 00	0.6500	2.50
0.35	0.50	45.20	0.0387	4.9947	1.1481616D 00	3.7801270D 00	0.6943	2.50
0.23	0.50	29.60	0.0388	4.9936	9.7251347D-01	3.6223166D 00	1.0600	2.50
0.71	0.50	90.50	0.0392	5.0009	4.3892182D-01	1.9262110D 00	0.3472	3.00
0.46	0.50	59.30	0.0388	5.0021	4.3437595D-01	1.9139783D 00	0.5300	3.00
0.38	0.50	48.30	0.0393	4.9967	4.6336932D-01	1.9078684D 00	0.6500	3.00
0.35	0.50	45.20	0.0387	4.9947	4.6106641D-01	1.9037166D 00	0.6943	3.00
0.23	0.50	29.60	0.0388	4.9936	4.2183496D-01	1.8830358D 00	1.0600	3.00
0.71	0.50	90.50	0.0392	5.0009	2.2546111D-01	1.1132422D 00	0.3472	3.50
0.46	0.50	59.30	0.0388	5.0021	2.3037414D-01	1.1153118D 00	0.5300	3.50
0.38	0.50	48.30	0.0393	4.9967	2.4082517D-01	1.1171123D 00	0.6500	3.50
0.35	0.50	45.20	0.0387	4.9947	2.4002702D-01	1.1161757D 00	0.6943	3.50
0.23	0.50	29.60	0.0388	4.9936	2.3126252D-01	1.1188020D 00	1.0600	3.50
0.71	0.50	90.50	0.0392	5.0009	1.4909135D-01	7.2732934D-01	0.3472	4.00
0.46	0.50	59.30	0.0388	5.0021	1.6161473D-01	7.3950231D-01	0.5300	4.00
0.38	0.50	48.30	0.0393	4.9967	1.6773948D-01	7.4447118D-01	0.6500	4.00
0.35	0.50	45.20	0.0387	4.9947	1.6784430D-01	7.4494190D-01	0.6943	4.00
0.23	0.50	29.60	0.0388	4.9936	1.6746195D-01	7.5237249D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.10	54.30	0.0597	3.0005	1.0671789D 00	3.6369518D 00	0.3472	2.50
0.70	0.10	35.60	0.0590	3.0029	1.0414233D 00	3.5567269D 00	0.5300	2.50
0.57	0.10	29.00	0.0590	3.0001	1.0019781D 00	3.4851641D 00	0.6500	2.50
0.53	0.10	27.10	0.0586	2.9946	9.8584844D-01	3.4588295D 00	0.6943	2.50
0.35	0.10	17.80	0.0590	3.0029	8.9539630D-01	3.2625311D 00	1.0600	2.50
1.08	0.10	54.30	0.0597	3.0005	3.9808975D-01	1.7473091D 00	0.3472	3.00
0.70	0.10	35.60	0.0590	3.0029	4.2088660D-01	1.7889937D 00	0.5300	3.00
0.57	0.10	29.00	0.0590	3.0001	4.2009393D-01	1.7851750D 00	0.6500	3.00
0.53	0.10	27.10	0.0586	2.9946	4.1809975D-01	1.7827536D 00	0.6943	3.00
0.35	0.10	17.80	0.0590	3.0029	4.0340739D-01	1.7459246D 00	1.0600	3.00
1.08	0.10	54.30	0.0597	3.0005	1.7613574D-01	9.6612302D-01	0.3472	3.50
0.70	0.10	35.60	0.0590	3.0029	2.0852951D-01	1.0305740D 00	0.5300	3.50
0.57	0.10	29.00	0.0590	3.0001	2.1617517D-01	1.0413180D 00	0.6500	3.50
0.53	0.10	27.10	0.0586	2.9946	2.1753958D-01	1.0443904D 00	0.6943	3.50
0.35	0.10	17.80	0.0590	3.0029	2.2098916D-01	1.0450070D 00	1.0600	3.50
1.08	0.10	54.30	0.0597	3.0005	9.2230429D-02	5.8910245D-01	0.3472	4.00
0.70	0.10	35.60	0.0590	3.0029	1.2871323D-01	6.6169872D-01	0.5300	4.00
0.57	0.10	29.00	0.0590	3.0001	1.4001251D-01	6.7855022D-01	0.6500	4.00
0.53	0.10	27.10	0.0586	2.9946	1.4287316D-01	6.8384981D-01	0.6943	4.00
0.35	0.10	17.80	0.0590	3.0029	1.5375475D-01	6.9781839D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT- DEL- ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.20	54.30	0.0597	3.0005	1.0844987D 00	3.6811288D 00	0.3472	2.50
0.70	0.20	35.60	0.0590	3.0029	1.0547704D 00	3.5927767D 00	0.5300	2.50
0.57	0.20	29.00	0.0590	3.0001	1.0025315D 00	3.5183816D 00	0.6500	2.50
0.53	0.20	27.10	0.0586	2.9946	9.9497402D-01	3.4938794D 00	0.6943	2.50
0.35	0.20	17.80	0.0590	3.0029	8.8940670D-01	3.2936956D 00	1.0600	2.50
1.08	0.20	54.30	0.0597	3.0005	4.0744546D-01	1.7809600D 00	0.3472	3.00
0.70	0.20	35.60	0.0590	3.0029	4.2879430D-01	1.8159101D 00	0.5300	3.00
0.57	0.20	29.00	0.0590	3.0001	4.2326627D-01	1.8089200D 00	0.6500	3.00
0.53	0.20	27.10	0.0586	2.9946	4.2428051D-01	1.8077132D 00	0.6943	3.00
0.35	0.20	17.80	0.0590	3.0029	4.0396184D-01	1.7673666D 00	1.0600	3.00
1.08	0.20	54.30	0.0597	3.0005	1.8299468D-01	9.9261680D-01	0.3472	3.50
0.70	0.20	35.60	0.0590	3.0029	2.1486003D-01	1.0515474D 00	0.5300	3.50
0.57	0.20	29.00	0.0590	3.0001	2.2038025D-01	1.0593308D 00	0.6500	3.50
0.53	0.20	27.10	0.0586	2.9946	2.2269400D-01	1.0632531D 00	0.6943	3.50
0.35	0.20	17.80	0.0590	3.0029	2.2335022D-01	1.0604448D 00	1.0600	3.50
1.08	0.20	54.30	0.0597	3.0005	9.8040927D-02	6.1063371D-01	0.3472	4.00
0.70	0.20	35.60	0.0590	3.0029	1.3488571D-01	6.7927919D-01	0.5300	4.00
0.57	0.20	29.00	0.0590	3.0001	1.4508594D-01	6.9363130D-01	0.6500	4.00
0.53	0.20	27.10	0.0586	2.9946	1.4822401D-01	6.9953568D-01	0.6943	4.00
0.35	0.20	17.80	0.0590	3.0029	1.5725184D-01	7.1027899D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE MICRONS LOWER-R1	SIZE MICRONS UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.50	54.30	0.0597	3.0005	1.1550186D 00	3.8096111D 00	0.3472	2.50
0.70	0.50	35.60	0.0590	3.0029	1.0107915D 00	3.6902848D 00	0.5300	2.50
0.57	0.50	29.00	0.0590	3.0001	1.0894772D 00	3.6187191D 00	0.6500	2.50
0.53	0.50	27.10	0.0586	2.9946	9.3664978D-01	3.5845646D 00	0.6943	2.50
0.35	0.50	17.80	0.0590	3.0029	9.1301531D-01	3.3745069D 00	1.0600	2.50
1.08	0.50	54.30	0.0597	3.0005	4.4460822D-01	1.8787701D 00	0.3472	3.00
0.70	0.50	35.60	0.0590	3.0029	4.2485450D-01	1.8887043D 00	0.5300	3.00
0.57	0.50	29.00	0.0590	3.0001	4.5690994D-01	1.8833081D 00	0.6500	3.00
0.53	0.50	27.10	0.0586	2.9946	4.1304522D-01	1.8797293D 00	0.6943	3.00
0.35	0.50	17.80	0.0590	3.0029	4.1465041D-01	1.8245460D 00	1.0600	3.00
1.08	0.50	54.30	0.0597	3.0005	2.0753918D-01	1.0697785D 00	0.3472	3.50
0.70	0.50	35.60	0.0590	3.0029	2.2390727D-01	1.1082553D 00	0.5300	3.50
0.57	0.50	29.00	0.0590	3.0001	2.3923972D-01	1.1168542D 00	0.6500	3.50
0.53	0.50	27.10	0.0586	2.9946	2.2632971D-01	1.1211384D 00	0.6943	3.50
0.35	0.50	17.80	0.0590	3.0029	2.3074909D-01	1.1004425D 00	1.0600	3.50
1.08	0.50	54.30	0.0597	3.0005	1.1772047D-01	6.7396398D-01	0.3472	4.00
0.70	0.50	35.60	0.0590	3.0029	1.4950719D-01	7.2733560D-01	0.5300	4.00
0.57	0.50	29.00	0.0590	3.0001	1.6159803D-01	7.4229531D-01	0.6500	4.00
0.53	0.50	27.10	0.0586	2.9946	1.5881928D-01	7.4939852D-01	0.6943	4.00
0.35	0.50	17.80	0.0590	3.0029	1.6596735D-01	7.4176170D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.10	90.50	0.0597	5.0009	1.1179455D 00	3.7666248D 00	0.3472	2.50
0.70	0.10	59.30	0.0590	5.0021	1.1078609D 00	3.7197244D 00	0.5300	2.50
0.57	0.10	48.30	0.0590	4.9967	1.0804681D 00	3.6682330D 00	0.6500	2.50
0.53	0.10	45.20	0.0586	4.9947	1.0688123D 00	3.6492100D 00	0.6943	2.50
0.35	0.10	29.60	0.0590	4.9936	1.0114858D 00	3.5000917D 00	1.0600	2.50
1.08	0.10	90.50	0.0597	5.0009	4.0422254D-01	1.7629334D 00	0.3472	3.00
0.70	0.10	59.30	0.0590	5.0021	4.3054469D-01	1.8132616D 00	0.5300	3.00
0.57	0.10	48.30	0.0590	4.9967	4.3321892D-01	1.8153862D 00	0.6500	3.00
0.53	0.10	45.20	0.0586	4.9947	4.3258982D-01	1.8152209D 00	0.6943	3.00
0.35	0.10	29.60	0.0590	4.9936	4.2735631D-01	1.7959398D 00	1.0600	3.00
1.08	0.10	90.50	0.0597	5.0009	1.7688045D-01	9.6801573D-01	0.3472	3.50
0.70	0.10	59.30	0.0590	5.0021	2.0994054D-01	1.0342065D 00	0.5300	3.50
0.57	0.10	48.30	0.0590	4.9967	2.1838358D-01	1.0463307D 00	0.6500	3.50
0.53	0.10	45.20	0.0586	4.9947	2.2008187D-01	1.0499571D 00	0.6943	3.50
0.35	0.10	29.60	0.0590	4.9936	2.2595281D-01	1.0555938D 00	1.0600	3.50
1.08	0.10	90.50	0.0597	5.0009	9.2321330D-02	5.8933294D-01	0.3472	4.00
0.70	0.10	59.30	0.0590	5.0021	1.2892044D-01	6.6224534D-01	0.5300	4.00
0.57	0.10	48.30	0.0590	4.9967	1.4038629D-01	6.7938634D-01	0.6500	4.00
0.53	0.10	45.20	0.0586	4.9947	1.4332114D-01	6.8480931D-01	0.6943	4.00
0.35	0.10	29.60	0.0590	4.9936	1.5478837D-01	7.0007120D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.20	90.50	0.0597	5.0009	1.1355232D 00	3.8108002D 00	0.3472	2.50
0.70	0.20	59.30	0.0590	5.0021	1.1248472D 00	3.7568998D 00	0.5300	2.50
0.57	0.20	48.30	0.0590	4.9967	1.0775955D 00	3.7007212D 00	0.6500	2.50
0.53	0.20	45.20	0.0586	4.9947	1.0801065D 00	3.6837535D 00	0.6943	2.50
0.35	0.20	29.60	0.0590	4.9936	1.0124547D 00	3.5314618D 00	1.0600	2.50
1.08	0.20	90.50	0.0597	5.0009	4.1360950D-01	1.7965840D 00	0.3472	3.00
0.70	0.20	59.30	0.0590	5.0021	4.3895425D-01	1.8403660D 00	0.5300	3.00
0.57	0.20	48.30	0.0590	4.9967	4.3584000D-01	1.8390254D 00	0.6500	3.00
0.53	0.20	45.20	0.0586	4.9947	4.3920487D-01	1.8401115D 00	0.6943	3.00
0.35	0.20	29.60	0.0590	4.9936	4.2939751D-01	1.8174272D 00	1.0600	3.00
1.08	0.20	90.50	0.0597	5.0009	1.8374331D-01	9.9450944D-01	0.3472	3.50
0.70	0.20	59.30	0.0590	5.0021	2.1634030D-01	1.0552114D 00	0.5300	3.50
0.57	0.20	48.30	0.0590	4.9967	2.2249876D-01	1.0643280D 00	0.6500	3.50
0.53	0.20	45.20	0.0586	4.9947	2.2532158D-01	1.0688108D 00	0.6943	3.50
0.35	0.20	29.60	0.0590	4.9936	2.2863336D-01	1.0710417D 00	1.0600	3.50
1.08	0.20	90.50	0.0597	5.0009	9.8132335D-02	6.1086419D-01	0.3472	4.00
0.70	0.20	59.30	0.0590	5.0021	1.3510247D-01	6.7983107D-01	0.5300	4.00
0.57	0.20	48.30	0.0590	4.9967	1.4544487D-01	6.9446519D-01	0.6500	4.00
0.53	0.20	45.20	0.0586	4.9947	1.4868850D-01	7.0049406D-01	0.6943	4.00
0.35	0.20	29.60	0.0590	4.9936	1.5835449D-01	7.1253407D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.08	0.50	90.50	0.0597	5.0009	1.2102650D 00	3.9396681D 00	0.3472	2.50
0.70	0.50	59.30	0.0590	5.0021	1.0751495D 00	3.8573366D 00	0.5300	2.50
0.57	0.50	48.30	0.0590	4.9967	1.1555887D 00	3.8052366D 00	0.6500	2.50
0.53	0.50	45.20	0.0586	4.9947	1.0142195D 00	3.7752126D 00	0.6943	2.50
0.35	0.50	29.60	0.0590	4.9936	1.0783920D 00	3.6255695D 00	1.0600	2.50
1.08	0.50	90.50	0.0597	5.0009	4.5138157D-01	1.8944762D 00	0.3472	3.00
0.70	0.50	59.30	0.0590	5.0021	4.3448423D-01	1.9136801D 00	0.5300	3.00
0.57	0.50	48.30	0.0590	4.9967	4.6798427D-01	1.9142412D 00	0.6500	3.00
0.53	0.50	45.20	0.0586	4.9947	4.2634965D-01	1.9122902D 00	0.6943	3.00
0.35	0.50	29.60	0.0590	4.9936	4.4915586D-01	1.8779077D 00	1.0600	3.00
1.08	0.50	90.50	0.0597	5.0009	2.0837305D-01	1.0716854D 00	0.3472	3.50
0.70	0.50	59.30	0.0590	5.0021	2.2535706D-01	1.1120103D 00	0.5300	3.50
0.57	0.50	48.30	0.0590	4.9967	2.4110836D-01	1.1220132D 00	0.6500	3.50
0.53	0.50	45.20	0.0586	4.9947	2.2862232D-01	1.1267293D 00	0.6943	3.50
0.35	0.50	29.60	0.0590	4.9936	2.3798709D-01	1.1118498D 00	1.0600	3.50
1.08	0.50	90.50	0.0597	5.0009	1.1782355D-01	6.7419671D-01	0.3472	4.00
0.70	0.50	59.30	0.0590	5.0021	1.4972679D-01	7.2790326D-01	0.5300	4.00
0.57	0.50	48.30	0.0590	4.9967	1.6191551D-01	7.4316049D-01	0.6500	4.00
0.53	0.50	45.20	0.0586	4.9947	1.5921614D-01	7.5036361D-01	0.6943	4.00
0.35	0.50	29.60	0.0590	4.9936	1.6749383D-01	7.4421412D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.10	54.30	0.0796	3.0005	1.0366896D 00	3.5262871D 00	0.3472	2.50
0.94	0.10	35.60	0.0793	3.0029	1.0258575D 00	3.5268754D 00	0.5300	2.50
0.76	0.10	29.00	0.0786	3.0001	9.9346770D-01	3.4713166D 00	0.6500	2.50
0.71	0.10	27.10	0.0785	2.9946	9.7896667D-01	3.4479594D 00	0.6943	2.50
0.46	0.10	17.80	0.0776	3.0029	8.9396541D-01	3.2605481D 00	1.0600	2.50
1.44	0.10	54.30	0.0796	3.0005	3.7028025D-01	1.6474538D 00	0.3472	3.00
0.94	0.10	35.60	0.0793	3.0029	4.0295123D-01	1.7548425D 00	0.5300	3.00
0.76	0.10	29.00	0.0786	3.0001	4.0937712D-01	1.7677794D 00	0.6500	3.00
0.71	0.10	27.10	0.0785	2.9946	4.0910034D-01	1.7685605D 00	0.6943	3.00
0.46	0.10	17.80	0.0776	3.0029	4.0102411D-01	1.7425690D 00	1.0600	3.00
1.44	0.10	54.30	0.0796	3.0005	1.5072967D-01	8.7586341D-01	0.3472	3.50
0.94	0.10	35.60	0.0793	3.0029	1.8802248D-01	9.9191626D-01	0.5300	3.50
0.76	0.10	29.00	0.0786	3.0001	2.0265752D-01	1.0194153D 00	0.6500	3.50
0.71	0.10	27.10	0.0785	2.9946	2.0575394D-01	1.0258263D 00	0.6943	3.50
0.46	0.10	17.80	0.0776	3.0029	2.1703299D-01	1.0394031D 00	1.0600	3.50
1.44	0.10	54.30	0.0796	3.0005	6.8982462D-02	5.0737226D-01	0.3472	4.00
0.94	0.10	35.60	0.0793	3.0029	1.0534789D-01	6.1809110D-01	0.5300	4.00
0.76	0.10	29.00	0.0786	3.0001	1.2293504D-01	6.5091944D-01	0.6500	4.00
0.71	0.10	27.10	0.0785	2.9946	1.2741654D-01	6.5952989D-01	0.6943	4.00
0.46	0.10	17.80	0.0776	3.0029	1.4719780D-01	6.8851032D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.20	54.30	0.0796	3.0005	1.0520684D 00	3.5768907D 00	0.3472	2.50
0.94	0.20	35.60	0.0793	3.0029	1.0264423D 00	3.5659785D 00	0.5300	2.50
0.76	0.20	29.00	0.0786	3.0001	9.9537313D-01	3.5071538D 00	0.6500	2.50
0.71	0.20	27.10	0.0785	2.9946	9.8931394D-01	3.4851702D 00	0.6943	2.50
0.46	0.20	17.80	0.0776	3.0029	9.0775939D-01	3.2905572D 00	1.0600	2.50
1.44	0.20	54.30	0.0796	3.0005	3.7732076D-01	1.6850214D 00	0.3472	3.00
0.94	0.20	35.60	0.0793	3.0029	4.0789297D-01	1.7841963D 00	0.5300	3.00
0.76	0.20	29.00	0.0786	3.0001	4.1385946D-01	1.7941990D 00	0.6500	3.00
0.71	0.20	27.10	0.0785	2.9946	4.1652344D-01	1.7958416D 00	0.6943	3.00
0.46	0.20	17.80	0.0776	3.0029	4.0738999D-01	1.7657713D 00	1.0600	3.00
1.44	0.20	54.30	0.0796	3.0005	1.5498129D-01	9.0417385D-01	0.3472	3.50
0.94	0.20	35.60	0.0793	3.0029	1.9382404D-01	1.0148838D 00	0.5300	3.50
0.76	0.20	29.00	0.0786	3.0001	2.0799961D-01	1.0399731D 00	0.6500	3.50
0.71	0.20	27.10	0.0785	2.9946	2.1205163D-01	1.0470040D 00	0.6943	3.50
0.46	0.20	17.80	0.0776	3.0029	2.2155052D-01	1.0574872D 00	1.0600	3.50
1.44	0.20	54.30	0.0796	3.0005	7.1959649D-02	5.2896601D-01	0.3472	4.00
0.94	0.20	35.60	0.0793	3.0029	1.1124675D-01	6.3700669D-01	0.5300	4.00
0.76	0.20	29.00	0.0786	3.0001	1.2877810D-01	6.6813842D-01	0.6500	4.00
0.71	0.20	27.10	0.0785	2.9946	1.3361694D-01	6.7725156D-01	0.6943	4.00
0.46	0.20	17.80	0.0776	3.0029	1.5188336D-01	7.0378190D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.50	54.30	0.0796	3.0005	1.0006984D 00	3.7213171D 00	0.3472	2.50
0.94	0.50	35.60	0.0793	3.0029	9.7690788D-01	3.6794330D 00	0.5300	2.50
0.76	0.50	29.00	0.0786	3.0001	1.0133720D 00	3.6064209D 00	0.6500	2.50
0.71	0.50	27.10	0.0785	2.9946	9.4444984D-01	3.5807071D 00	0.6943	2.50
0.46	0.50	17.80	0.0776	3.0029	8.6457311D-01	3.3790479D 00	1.0600	2.50
1.44	0.50	54.30	0.0796	3.0005	3.7005585D-01	1.7882907D 00	0.3472	3.00
0.94	0.50	35.60	0.0793	3.0029	4.0580150D-01	1.8663041D 00	0.5300	3.00
0.76	0.50	29.00	0.0786	3.0001	4.3398377D-01	1.8674465D 00	0.6500	3.00
0.71	0.50	27.10	0.0785	2.9946	4.1257459D-01	1.8689788D 00	0.6943	3.00
0.46	0.50	17.80	0.0776	3.0029	3.9787912D-01	1.8251511D 00	1.0600	3.00
1.44	0.50	54.30	0.0796	3.0005	1.5898561D-01	9.7870310D-01	0.3472	3.50
0.94	0.50	35.60	0.0793	3.0029	2.0455711D-01	1.0771331D 00	0.5300	3.50
0.76	0.50	29.00	0.0786	3.0001	2.2589013D-01	1.0966934D 00	0.6500	3.50
0.71	0.50	27.10	0.0785	2.9946	2.2128088D-01	1.1044144D 00	0.6943	3.50
0.46	0.50	17.80	0.0776	3.0029	2.2373067D-01	1.0983876D 00	1.0600	3.50
1.44	0.50	54.30	0.0796	3.0005	7.8068597D-02	5.8400666D-01	0.3472	4.00
0.94	0.50	35.60	0.0793	3.0029	1.2614486D-01	6.8779927D-01	0.5300	4.00
0.76	0.50	29.00	0.0786	3.0001	1.4655369D-01	7.1605606D-01	0.6500	4.00
0.71	0.50	27.10	0.0785	2.9946	1.4841050D-01	7.2593181D-01	0.6943	4.00
0.46	0.50	17.80	0.0776	3.0029	1.6037324D-01	7.3619224D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.10	90.50	0.0796	5.0009	1.0874562D 00	3.6559601D 00	0.3472	2.50
0.94	0.10	59.30	0.0793	5.0021	1.0922951D 00	3.6898729D 00	0.5300	2.50
0.76	0.10	48.30	0.0786	4.9967	1.0719578D 00	3.6543855D 00	0.6500	2.50
0.71	0.10	45.20	0.0785	4.9947	1.0619306D 00	3.6383399D 00	0.6943	2.50
0.46	0.10	29.60	0.0776	4.9936	1.0100549D 00	3.4981087D 00	1.0600	2.50
1.44	0.10	90.50	0.0796	5.0009	3.7641304D-01	1.6630780D 00	0.3472	3.00
0.94	0.10	59.30	0.0793	5.0021	4.1260931D-01	1.7791104D 00	0.5300	3.00
0.76	0.10	48.30	0.0786	4.9967	4.2250212D-01	1.7979906D 00	0.6500	3.00
0.71	0.10	45.20	0.0785	4.9947	4.2359040D-01	1.8010279D 00	0.6943	3.00
0.46	0.10	29.60	0.0776	4.9936	4.2497303D-01	1.7925842D 00	1.0600	3.00
1.44	0.10	90.50	0.0796	5.0009	1.5147438D-01	8.7775611D-01	0.3472	3.50
0.94	0.10	59.30	0.0793	5.0021	1.8943351D-01	9.9554883D-01	0.5300	3.50
0.76	0.10	48.30	0.0786	4.9967	2.0486592D-01	1.0244280D 00	0.6500	3.50
0.71	0.10	45.20	0.0785	4.9947	2.0829623D-01	1.0313930D 00	0.6943	3.50
0.46	0.10	29.60	0.0776	4.9936	2.2199665D-01	1.0499898D 00	1.0600	3.50
1.44	0.10	90.50	0.0796	5.0009	6.9073363D-02	5.0760275D-01	0.3472	4.00
0.94	0.10	59.30	0.0793	5.0021	1.0555509D-01	6.1863772D-01	0.5300	4.00
0.76	0.10	48.30	0.0786	4.9967	1.2330882D-01	6.5175556D-01	0.6500	4.00
0.71	0.10	45.20	0.0785	4.9947	1.2786451D-01	6.6048940D-01	0.6943	4.00
0.46	0.10	29.60	0.0776	4.9936	1.4823142D-01	6.9076312D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.20	90.50	0.0796	5.0009	1.1030929D 00	3.7065620D 00	0.3472	2.50
0.94	0.20	59.30	0.0793	5.0021	1.0898185D 00	3.7284928D 00	0.5300	2.50
0.76	0.20	48.30	0.0786	4.9967	1.0704372D 00	3.6894933D 00	0.6500	2.50
0.71	0.20	45.20	0.0785	4.9947	1.0744464D 00	3.6750443D 00	0.6943	2.50
0.46	0.20	29.60	0.0776	4.9936	1.0170238D 00	3.5299758D 00	1.0600	2.50
1.44	0.20	90.50	0.0796	5.0009	3.8348479D-01	1.7006453D 00	0.3472	3.00
0.94	0.20	59.30	0.0793	5.0021	4.1716095D-01	1.8084012D 00	0.5300	3.00
0.76	0.20	48.30	0.0786	4.9967	4.2643320D-01	1.8243043D 00	0.6500	3.00
0.71	0.20	45.20	0.0785	4.9947	4.3144780D-01	1.8282399D 00	0.6943	3.00
0.46	0.20	29.60	0.0776	4.9936	4.2992454D-01	1.8163131D 00	1.0600	3.00
1.44	0.20	90.50	0.0796	5.0009	1.5572992D-01	9.0606650D-01	0.3472	3.50
0.94	0.20	59.30	0.0793	5.0021	1.9518651D-01	1.0185082D 00	0.5300	3.50
0.76	0.20	48.30	0.0786	4.9967	2.1011812D-01	1.0449703D 00	0.6500	3.50
0.71	0.20	45.20	0.0785	4.9947	2.1467921D-01	1.0525617D 00	0.6943	3.50
0.46	0.20	29.60	0.0776	4.9936	2.2621939D-01	1.0682149D 00	1.0600	3.50
1.44	0.20	90.50	0.0796	5.0009	7.2051058D-02	5.2919649D-01	0.3472	4.00
0.94	0.20	59.30	0.0793	5.0021	1.1144812D-01	6.3755224D-01	0.5300	4.00
0.76	0.20	48.30	0.0786	4.9967	1.2913703D-01	6.6897231D-01	0.6500	4.00
0.71	0.20	45.20	0.0785	4.9947	1.3408143D-01	6.7820994D-01	0.6943	4.00
0.46	0.20	29.60	0.0776	4.9936	1.5285520D-01	7.0607108D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.44	0.50	90.50	0.0796	5.0009	1.0555122D 00	3.8525547D 00	0.3472	2.50
0.94	0.50	59.30	0.0793	5.0021	1.0590633D 00	3.8430611D 00	0.5300	2.50
0.76	0.50	48.30	0.0786	4.9967	1.0881136D 00	3.7921112D 00	0.6500	2.50
0.71	0.50	45.20	0.0785	4.9947	1.0405297D 00	3.7781661D 00	0.6943	2.50
0.46	0.50	29.60	0.0776	4.9936	9.5007378D-01	3.6237129D 00	1.0600	2.50
1.44	0.50	90.50	0.0796	5.0009	3.7666075D-01	1.8041258D 00	0.3472	3.00
0.94	0.50	59.30	0.0793	5.0021	4.1776281D-01	1.8907158D 00	0.5300	3.00
0.76	0.50	48.30	0.0786	4.9967	4.4665658D-01	1.8981539D 00	0.6500	3.00
0.71	0.50	45.20	0.0785	4.9947	4.2938554D-01	1.9027910D 00	0.6943	3.00
0.46	0.50	29.60	0.0776	4.9936	4.1564929D-01	1.8769887D 00	1.0600	3.00
1.44	0.50	90.50	0.0796	5.0009	1.5978649D-01	9.8062431D-01	0.3472	3.50
0.94	0.50	59.30	0.0793	5.0021	2.0630669D-01	1.0807945D 00	0.5300	3.50
0.76	0.50	48.30	0.0786	4.9967	2.2805254D-01	1.1017998D 00	0.6500	3.50
0.71	0.50	45.20	0.0785	4.9947	2.2423590D-01	1.1102370D 00	0.6943	3.50
0.46	0.50	29.60	0.0776	4.9936	2.2743727D-01	1.1094334D 00	1.0600	3.50
1.44	0.50	90.50	0.0796	5.0009	7.8166318D-02	5.8424102D-01	0.3472	4.00
0.94	0.50	59.30	0.0793	5.0021	1.2640199D-01	6.8835130D-01	0.5300	4.00
0.76	0.50	48.30	0.0786	4.9967	1.4692484D-01	7.1690988D-01	0.6500	4.00
0.71	0.50	45.20	0.0785	4.9947	1.4893225D-01	7.2694009D-01	0.6943	4.00
0.46	0.50	29.60	0.0776	4.9936	1.6114913D-01	7.3855923D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	UPPER-R2	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.80	0.10	181.90	0.0995	10.0515	1.1373449D 00	3.6239867D 00	0.3472	2.50
1.18	0.10	181.90	0.0995	15.3437	1.1680113D 00	3.8700424D 00	0.5300	2.50
0.96	0.10	181.90	0.0993	18.8177	1.1885919D 00	3.9201421D 00	0.6500	2.50
0.90	0.10	181.00	0.0995	20.0007	1.1925194D 00	3.9292623D 00	0.6943	2.50
0.58	0.10	118.60	0.0978	20.0083	1.1746982D 00	3.8881675D 00	1.0600	2.50
1.80	0.10	181.90	0.0995	10.0515	3.7394381D-01	1.5474224D 00	0.3472	3.00
1.18	0.10	181.90	0.0995	15.3437	4.0034784D-01	1.7501063D 00	0.5300	3.00
0.96	0.10	181.90	0.0993	18.8177	4.2064277D-01	1.7994140D 00	0.6500	3.00
0.90	0.10	181.00	0.0995	20.0007	4.2544378D-01	1.8104380D 00	0.6943	3.00
0.58	0.10	118.60	0.0978	20.0083	4.4411465D-01	1.8407610D 00	1.0600	3.00
1.80	0.10	181.90	0.0995	10.0515	1.4572500D-01	7.7798224D-01	0.3472	3.50
1.18	0.10	181.90	0.0995	15.3437	1.6855584D-01	9.4570605D-01	0.5300	3.50
0.96	0.10	181.90	0.0993	18.8177	1.8858326D-01	9.9426211D-01	0.6500	3.50
0.90	0.10	181.00	0.0995	20.0007	1.9390317D-01	1.0062240D 00	0.6943	3.50
0.58	0.10	118.60	0.0978	20.0083	2.1917421D-01	1.0485603D 00	1.0600	3.50
1.80	0.10	181.90	0.0995	10.0515	6.4116609D-02	4.2764352D-01	0.3472	4.00
1.18	0.10	181.90	0.0995	15.3437	8.3932841D-02	5.6705719D-01	0.5300	4.00
0.96	0.10	181.90	0.0993	18.8177	1.0371020D-01	6.1490222D-01	0.6500	4.00
0.90	0.10	181.00	0.0995	20.0007	1.0948094D-01	6.2760118D-01	0.6943	4.00
0.58	0.10	118.60	0.0978	20.0083	1.3974769D-01	6.7853245D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.80	0.20	181.90	0.0995	10.0515	1.1310783D 00	3.6820721D 00	0.3472	2.50
1.18	0.20	181.90	0.0995	15.3437	1.1676147D 00	3.9146528D 00	0.5300	2.50
0.96	0.20	181.90	0.0993	18.8177	1.1876601D 00	3.9597711D 00	0.6500	2.50
0.90	0.20	181.00	0.0995	20.0007	1.2101587D 00	3.9699904D 00	0.6943	2.50
0.58	0.20	118.60	0.0978	20.0083	1.1710813D 00	3.9215058D 00	1.0600	2.50
1.80	0.20	181.90	0.0995	10.0515	3.7380823D-01	1.5900542D 00	0.3472	3.00
1.18	0.20	181.90	0.0995	15.3437	4.0523531D-01	1.7835863D 00	0.5300	3.00
0.96	0.20	181.90	0.0993	18.8177	4.2551954D-01	1.8292377D 00	0.6500	3.00
0.90	0.20	181.00	0.0995	20.0007	4.3497011D-01	1.8408414D 00	0.6943	3.00
0.58	0.20	118.60	0.0978	20.0083	4.4673129D-01	1.8646658D 00	1.0600	3.00
1.80	0.20	181.90	0.0995	10.0515	1.4666487D-01	8.0914244D-01	0.3472	3.50
1.18	0.20	181.90	0.0995	15.3437	1.7391812D-01	9.7139527D-01	0.5300	3.50
0.96	0.20	181.90	0.0993	18.8177	1.9443916D-01	1.0175658D 00	0.6500	3.50
0.90	0.20	181.00	0.0995	20.0007	2.0114154D-01	1.0300193D 00	0.6943	3.50
0.58	0.20	118.60	0.0978	20.0083	2.2336849D-01	1.0667254D 00	1.0600	3.50
1.80	0.20	181.90	0.0995	10.0515	6.5064428D-02	4.5040584D-01	0.3472	4.00
1.18	0.20	181.90	0.0995	15.3437	8.8858049D-02	5.8733780D-01	0.5300	4.00
0.96	0.20	181.90	0.0993	18.8177	1.0961544D-01	6.3401952D-01	0.6500	4.00
0.90	0.20	181.00	0.0995	20.0007	1.1599788D-01	6.4724053D-01	0.6943	4.00
0.58	0.20	118.60	0.0978	20.0083	1.4487706D-01	6.9374272D-01	1.0600	4.00

LOWER LIMIT ALPHA-1	INCRMT DEL-ALPHA	UPPER LIMIT ALPHA-2	SIZE LOWER-R1 MICRONS	SIZE UPPER-R2 MICRONS	PHI 180 DEGREES	KAPPA	LAMBDA MICRONS	NU
1.80	0.50	181.90	0.0995	10.0515	1.1522568D 00	3.8499221D 00	0.3472	2.50
1.18	0.50	181.90	0.0995	15.3437	1.1434566D 00	4.0438760D 00	0.5300	2.50
0.96	0.50	181.90	0.0993	18.8177	1.1653746D 00	4.0757800D 00	0.6500	2.50
0.90	0.50	181.00	0.0995	20.0007	1.2673026D 00	4.0855114D 00	0.6943	2.50
0.58	0.50	118.60	0.0978	20.0083	1.2573228D 00	4.0274939D 00	1.0600	2.50
1.80	0.50	181.90	0.0995	10.0515	3.8832907D-01	1.7063697D 00	0.3472	3.00
1.18	0.50	181.90	0.0995	15.3437	4.1191030D-01	1.8818397D 00	0.5300	3.00
0.96	0.50	181.90	0.0993	18.8177	4.2759070D-01	1.9122655D 00	0.6500	3.00
0.90	0.50	181.00	0.0995	20.0007	4.6305626D-01	1.9211453D 00	0.6943	3.00
0.58	0.50	118.60	0.0978	20.0083	4.7977945D-01	1.9406107D 00	1.0600	3.00
1.80	0.50	181.90	0.0995	10.0515	1.5474805D-01	8.9003661D-01	0.3472	3.50
1.18	0.50	181.90	0.0995	15.3437	1.8783604D-01	1.0484294D 00	0.5300	3.50
0.96	0.50	181.90	0.0993	18.8177	2.0612538D-01	1.0802970D 00	0.6500	3.50
0.90	0.50	181.00	0.0995	20.0007	2.2139035D-01	1.0902692D 00	0.6943	3.50
0.58	0.50	118.60	0.0978	20.0083	2.4208558D-01	1.1250231D 00	1.0600	3.50
1.80	0.50	181.90	0.0995	10.0515	6.9555747D-02	5.0704779D-01	0.3472	4.00
1.18	0.50	181.90	0.0995	15.3437	1.0378684D-01	6.4959970D-01	0.5300	4.00
0.96	0.50	181.90	0.0993	18.8177	1.2478515D-01	6.8502296D-01	0.6500	4.00
0.90	0.50	181.00	0.0995	20.0007	1.3466255D-01	6.9656322D-01	0.6943	4.00
0.58	0.50	118.60	0.0978	20.0083	1.6139018D-01	7.4297241D-01	1.0600	4.00

APPENDIX IV

This appendix lists the computer programs used for the calculations of the tabulated quantities in Appendixes II and III.

```
C MIE A AND B MAIN PROGRAM
      DOUBLE PRECISION SREF(2),S,SLAST,DELTA
      DOUBLE PRECISION WN(2),WNM1(2),WNM2(2),ALAST(2),ANEXT(2),REF(2),A(
     12),B(2),X,FN,U,V,SU,CU,W,W1,SHV,CHV,TEM1,TEST
      COMMON REF,X,A,B,FN,WN,WNM1,WNM2,ALAST,ANEXT
      READ(1,5)S,DELTA,SLAST
      READ(1,5)SREF
    5 FORMAT(3F10.8)
 1101 WRITE(13,66)SREF,S
   66 FORMAT(1H110X 6HRE(N)=F10.5,5X6HIM(N)=F10.5,10X6HALPHA=F10.5/1H 3X
     11HM 9X5HRE(A) 14X5HIM(A) 14X5HRE(B) 14X5HIM(B))
      WRITE(3,999)SREF,S
  999 FORMAT(3F10.4)
C INITIALIZATION
  101 FN=0.D0
      TEST = (1.2D0)*S+9.D0
      X=S
      WN(1)=DSIN(X)
      WN(2)=DCOS(X)
      WNM1(1)=WN(2)
      WNM1(2)=-WN(1)
      REF(1)=SREF(1)
      REF(2)=SREF(2)
      U=REF(1)*X
      V=-REF(2)*X
      SU=DSIN(U)
      CU=DCOS(U)
      W=DEXP(V)
      W1=1.D0/W
      SHV=0.5D0*(W-W1)
      CHV=0.5D0*(W+W1)
      TEM1=1.D0/(SU*SU+SHV*SHV)
      ANEXT(1)=SU*CU*TEM1
      ANEXT(2)=SHV*CHV*TEM1
C STEP UP FOR NEXT CALCULATION
    3 ALAST(1)=ANEXT(1)
      ALAST(2)= ANEXT(2)
      WNM2(1)=WNM1(1)
      WNM2(2)=WNM1(2)
      WNM1(1)=WN(1)
      WNM1(2)=WN(2)
      FN=FN+1.D0
C COMPUT A'S AND B'S
      CALL NEXTAB
      N=FN
      WRITE(13,7)N,A,B
    7 FORMAT(1H I4,5X1PD14.7,5XD14.7,5XD14.7, 5XD14.7)
      IF(FN-TEST) 102,9,9
  102 IF(DABS(A(1))-1.D-8)2,2,3
    2 IF(DABS(A(2))-1.D-8)4,4,3
    4 IF(DABS(B(1))-1.D-8)8,8,3
    8 IF(DABS(B(2))-1.D-8)9,9,3
```

```
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    9 IF(S-SLAST)12,10,10
   12 N=0
      A(1)=0.
      WRITE(13,7)N,A(1),A(1),A(1),A(1)
      S=S+DELTA
      GO TO 1101
   10 N=-1
      A(1)=0.
      WRITE(13,7)N,A(1),A(1),A(1),A(1)
      REWIND 13
      CALL EXIT
      END
```

```
      SUBROUTINE NEXTAB
      DOUBLE PRECISION WN(2),WNM1(2),WNM2(2),ALAST(2),ANEXT(2),REF(2),A(
     12),B(2),X,FN
      COMMON REF,X,A,B,FN,WN,WNM1,WNM2,ALAST,ANEXT
      DOUBLE PRECISION STORE1(2),STORE2(2),ADENOM(2),BDENOM(2),ANUM(2),
     1BNUM(2),DEN1,TERM1,DENOM1,DENOM2,TEMP,FACT,STORE,TERM2
C CALCULATE NEXT A&B FROM LAST
      DEN1=(REF(1)*REF(1)+REF(2)*REF(2))*X
      TERM1=FN/DEN1
      TERM2=TERM1*REF(2)
      TERM1=-TERM1*REF(1)
      DENOM1=-TERM1-ALAST(1)
      DENOM2=-TERM2-ALAST(2)
      TEMP=1.D0/(DENOM1*DENOM1+DENOM2*DENOM2)
      ANEXT(1)=TERM1+DENOM1*TEMP
      ANEXT(2)=TERM2-DENOM2*TEMP
      FACT=(2.D0*FN-1.D0)/X
      WN(1)=FACT*WNM1(1)-WNM2(1)
      WN(2)=FACT*WNM1(2)-WNM2(2)
      STORE=FN/X
      CALL DIVCPX(ANEXT,REF,STORE1)
      STORE1(1)=STORE1(1)+STORE
      CALL MPYCPX(STORE1,WN,STORE2)
      CALL SUBCPX(STORE2,WNM1,ADENOM)
      ANUM(1)=WN(1)*STORE1(1)
      ANUM(2)=WN(1)*STORE1(2)
      ANUM(1)=ANUM(1)-WNM1(1)
      CALL DIVCPX(ANUM,ADENOM,A)
      CALL MPYCPX(ANEXT,REF,STORE1)
      STORE1(1)=STORE1(1)+STORE
      CALL MPYCPX(STORE1,WN,STORE2)
      CALL SUBCPX(STORE2,WNM1,BDENOM)
      BNUM(1)=WN(1)*STORE1(1)
      BNUM(2)=WN(1)*STORE1(2)
      BNUM(1)=BNUM(1)-WNM1(1)
      CALL DIVCPX(BNUM,BDENOM,B)
      RETURN
      END
```

```
SUBROUTINE SUBCPX(X,Y,Z)
DOUBLE PRECISION X(2),Y(2),Z(2)
Z(1)=X(1)-Y(1)
Z(2)=X(2)-Y(2)
RETURN
END
```

```
SUBROUTINE MPYCPX(X,Y,Z)
DOUBLE PRECISION X(2),Y(2),Z(2),Z1,Z2
Z1=X(1)*Y(1)-X(2)*Y(2)
Z2=X(1)*Y(2)+X(2)*Y(1)
Z(1)=Z1
Z(2)=Z2
RETURN
END
```

```
      SUBROUTINE DIVCPX(X,Y,Z)
      DOUBLE PRECISION X(2),Y(2),Z(2),Z1,Z2,DENOM
      DENOM=Y(1)*Y(1)+Y(2)*Y(2)
      Z1=(X(1)*Y(1)+X(2)*Y(2))/DENOM
      Z2=(X(2)*Y(1)-X(1)*Y(2))/DENOM
      Z(1)=Z1
      Z(2)= Z2
      RETURN
      END
```

```
C
C     THIS PROGRAM CALCULATES INTENSITIES, QE, AND QS
C
      DOUBLE PRECISION SRE,SIM,Y,Z,W,SSQMRI,C,ZERO
      DIMENSION M(500)
      DOUBLE PRECISION REA(500),REB(500),IMA(500),IMB(500),       ALPHA,
     1         SUMRE,SUMIM,SUM1,SUM2,QE,QS,INTSTY,SQMGRE,SQMGIM,XI
      DOUBLE PRECISION HALF,ONE,TWO
C
      ZERO=0.0
      ONE  = 1.0D0
      TWO  = 2.0D0
      HALF = 0.5D0
      LINS=50
      IDEG=180
      READ(1,1000)NOALPS
      WRITE(3,1000)NOALPS
      WRITE(14)NOALPS,IDEG,ZERO,ZERO
      WRITE(3,2000)NOALPS,  IDEG,ZERO,ZERO
 2000 FORMAT(2I10,2F15.5)
      NO=0
      READ(13,1111)
      READ(13,1121)
      WRITE(3,1111)
      WRITE(3,1121)
   39 L=0
   40 WRITE(3,100)
      WRITE(3,102)
   10 READ(13) N,ALPHA,Y,Z,W
      IF(ALPHA-182.0D0)19,70,70
   19 IF(Y) 10,20,10
   20 IF(N) 51,10,30
   30 MAX = N
      READ(13)(M(I),REA(I),IMA(I),REB(I),IMB(I),I=1,N)
C
C     INITIALIZATIONS
C
      SUMRE = 0.0D0
      SUMIM = 0.0D0
      SUM1  = 0.0D0
      SUM2  = 0.0D0
      N = MAX
      C=-1.0
      DO 45 I=1,N
      C=-C
      XI=I
      SUMRE=C*(XI+.5)*(REA(I)-REB(I))+SUMRE
      SUMIM=C*(XI+.5)*(IMA(I)-IMB(I))+SUMIM
   45 CONTINUE
      SQMGRE=SUMRE*SUMRE
      SQMGIM=SUMIM*SUMIM
      INTSTY=SQMGRE+SQMGIM
```

```
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      SUMRE = 0.0D0
      SUMIM = 0.0D0
      SUM1  = 0.0D0
      SUM2  = 0.0D0
      N = MAX
      DO 90 I=1,N
      XI=I
      SRE=REA(I)+REB(I)
      SIM=IMA(I)+IMB(I)
      SQMGRE=REA(I)*REA(I)+REB(I)*REB(I)
      SQMGIM=IMA(I)*IMA(I)+IMB(I)*IMB(I)
      SUMRE=(XI+HALF)*SRE+SUMRE
      SUMIM= (XI+HALF)*SIM+SUMIM
      SUM1=(TWO*XI+ONE)*(SRE)+SUM1
      SUM2=(TWO*XI+ONE)*(SQMGRE+SQMGIM)+SUM2
   90 CONTINUE
      QE=(TWO*SUM1)/(ALPHA*ALPHA)
      QS=(TWO*SUM2)/(ALPHA*ALPHA)
      WRITE(14,103)ALPHA,MAX,QE,QS,INTSTY
      NO=NO+1
      WRITE(3,101)ALPHA,MAX,QS, INTSTY
      L=L+1
      IF(LINS-L) 60, 39, 10
   51 IF(N+1) 70, 52, 70
   52 READ(13,1111)
      WRITE(3,1111)
      WRITE(3,1122)
      READ(13,1122)
      GO TO 39
   70 WRITE(3,1051)
      WRITE(3,1001)NOALPS,NO
      WRITE(15,1002)
      CALL EXIT
   60 WRITE(3,1060)
      GO TO 39
C
  100 FORMAT('1',T26,'BACK SCATTER INTENSITY FUNCTIONS'/)
  101 FORMAT(' ',T12,F7.2,T28,I4,T40,1PD14.7,6X,D14.7)
  102 FORMAT(' ',T14,'ALPHA',T25,'NO. OF TERMS',T45,'QS',T64,'I(180)'/)
  103 FORMAT(F9.4,8X,I5,7X1PD14.8,2(4XD14.8))
 1000 FORMAT(I5)
 1001 FORMAT('  NUMBER OF ALPHAS USED IS ',I5,', NUMBER OF INTENSITIES'/
     1,      '  CALCULATED IS ',I5,'.  I''S ARE ON TAPE DRIVE 181.')
 1002 FORMAT(' OPERATOR: PLEASE REWIND BOTH TAPE DRIVES. THANK YOU.')
 1060 FORMAT('1 PROGRAM ERROR')
 1111 FORMAT('1 THE FOLLOWING DATA ARE                  A''S & B''S')
 1121 FORMAT('  USING N= 1.50, ALPHA= .01(.01)2.0')
 1122 FORMAT('  USING N= 1.50, ALPHA= 2.0(0.1)180.0')
 1051 FORMAT('1 PROGRAM COMPLETE, NORMAL EXIT CALLED')
C
      END
```

```
C
      DOUBLE PRECISION SIGMA,H,S,FA,A1,A2,R1,R2,DA,DELA,LAMDA,A,F
      DOUBLE PRECISION Z,W,SUMZ,SUMW,INTSTY(2000),QE(2000),ALPHA(2000)
      DOUBLE PRECISION ETA,LAMO2P,TWOPI,B,D,ZERO
      F(A,X)=1.0/A**X
      ZERO=0
      TWOPI= 6.2831853071796
      LINS=19
C
C     READ INTENSITIES FOR ALPHA=.01(.01)1.99,2.0(.1)182.
C
    8 READ( 14)NOALPS,IDEG,ZERO,ZERO
      NOALPS=1999
      DO 2 I=1,NOALPS
      READ(14,1000)ALPHA(I),QE(I),INTSTY(I)
    2 CONTINUE
      WRITE(3,1001)NOALPS
 1001 FORMAT('     NOALPHAS=   ',I4)
    9 L=0
      WRITE(3,1030)
      WRITE(3,1031)
      WRITE(3,1032)IDEG
   11 READ(1,1010)A1,DA,A2,XNU,LAMDA
      IF(A2-ALPHA(NOALPS))700,700,800
  800 A2=ALPHA(NOALPS)
  700 CONTINUE
      ETA=0
      SIGMA=0
      SUMZ=0
      SUMW=0
      I=1
      IF(A1)130,135,13
  135 IF(DA)8,125,125
   13 XNUP1=XNU+1.
      XNUM1=XNU-1
      LAMO2P=LAMDA/TWOPI
      IF(A1-1.99D0)120,121,12
  121 A1=2.0D0
      GO TO 12
  120 INDX1=(DA/.01D0)+.5
      ISTRT1=(A1/.01D0)+.5
      DELA=DA
      IF(DA-.01D0)118,118,119
  118 INDX1=1
C
C     LOWER INTEGRAL STARTS HERE
C
      J=ISTRT1
      A=ALPHA(J)
      ETA=INTSTY(J)*F(A,XNUP1)
      SIGMA=0.5D0*QE(J)*F(A,XNUM1)
      ISTRT1=J+1
```

```
07/27/67              FORTMAIN
  119 DO 122 J=ISTRT1,199,INDX1
      A=ALPHA(J)
      Z=2.DO*INTSTY(J)*F(A,XNUP1)
      W=QE(J)*F(A,XNUM1)
      ETA=ETA+Z
      SIGMA=SIGMA+W
  122 JJ=J
      ISTRT=((JJ+INDX1+5)/10)+180
      ETA=DA*(ETA-.5DO*Z)
      SIGMA=DA*(SIGMA-.5DO*W)
C
C     ADD PATCH INTERVAL
C
      A=ALPHA(JJ)
      B=ALPHA(ISTRT)
      D=B-A
      Z=INTSTY(JJ)*F(A,XNUP1)
      W=INTSTY(ISTRT)*F(B,XNUP1)
      ETA=ETA+D*(Z+W)
      Z=QE(JJ)*F(A,XNUM1)
      W=QE(ISTRT)*F(B,XNUM1)
      SIGMA=SIGMA+.5DO*D*(Z+W)
C
   12 I=1
      INDX =(DA/.1DO)+.5
      IFIN=(A2/.1DO)+180.5
      ISTRT1=ISTRT1-1
      R1=ALPHA(ISTRT1)*LAMO2P
      R2=ALPHA( IFIN )*LAMO2P
      IF(INDX1-1)18,18,19
   18 INDX=1
      DA=.1DO
C
C     UPPER INTEGRAL STARTS HERE
C
      J=ISTRT
      A=ALPHA(J)
      SUMZ=INTSTY(J)*F(A,XNUP1)
      SUMW=.5DO*QE(J)*F(A,XNUM1)
      ISTRT=J+1
   19 DO 20 J=ISTRT,IFIN,INDX
      A=ALPHA(J)
      Z=2.DO*INTSTY(J)*F(A,XNUP1)
      W=QE(J)*F(A,XNUM1)
      SUMZ=SUMZ+Z
      SUMW=SUMW+W
   20 JJ=J
      SUMZ=DA*(SUMZ-.5DO*Z)
      SUMW=DA*(SUMW-.5DO*W)
      ETA=ETA+SUMZ
      SIGMA=SIGMA+SUMW
      L=L+1
      WRITE(3,1040)ALPHA(ISTRT1),DELA,ALPHA(IFIN),R1,R2,ETA,SIGMA,LAMDA,
```

```
07/27/67             FORTMAIN
     1             XNU
      IF(LINS-L)9,11,11
C
  125 WRITE(3,1080)
      WRITE(3,1125)
      REWIND 13
   50 CALL EXIT
  130 WRITE(3,1130)
      GO TO 9
C
  999 FORMAT(I3)
 1000 FORMAT(F9.4,20X,D14.8,22X,D14.8)
 1010 FORMAT(5F10.4)
 1030 FORMAT('1',T7,'LOWER   INCRMT   UPPER',T38,'SIZE',
     1T5,'|',T13,'|',T22,'|',T31,'|',T50,'|',T66,'|',T81,'|',T91,'|',
     2T97,'|' )
 1031 FORMAT(T7,'LIMIT',T16,'DEL-     LIMIT   LOWER-R1 UPPER-R2',T57,'PHI
     1',T71,'OMEGA',T83,'LAMBDA',T94,'NU',
     2T5,'|',T13,'|',T22,'|',T31,'|',T50,'|',T66,'|',T81,'|',T91,'|',
     3T97,'|' )
 1032 FORMAT(T6,'ALPHA-1  ALPHA   ALPHA-2',T37,'MICRONS',T53,I3,T57,
     1'DEGREES',T83,'MICRONS',T97,'|',
     2T5,'|',T13,'|',T22,'|',T31,'|',T50,'|',T66,'|',T81,'|',T91,'|'//)
 1040 FORMAT(4X,F7.2,F8.2,F9.2,F9.4,F10.4,2(2X,1PD14.7),0PF9.4,F7.2)
 1080 FORMAT('1')
 1125 FORMAT('1 END OF PROGRAM, CALCULATIONS COMPLETED.')
 1130 FORMAT(' ALPHA1 IS NEGATIVE, DOES NOT COMPUTE ')
C
      END
```

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VITA

The author, Michael Patrick McCormick, was born in Canonsburg, Pennsylvania, on November 23, 1940. He completed his elementary and secondary education in Canonsburg. After graduation from high school in 1958, the author entered Washington and Jefferson College, Washington, Pennsylvania. After receiving his Bachelor of Arts degree, with honors in Physics in 1962, the author served with the United States Bureau of Mines, Health and Safety Activity, Pittsburgh, Pennsylvania, for the summer, entering the College of William and Mary in the fall. The requirements for his Master of Arts Degree were completed in 1964 with a thesis entitled "Scintillations in the Ionosphere." Since that time the author has been performing the research for this paper while pursuing his doctoral degree.